Hygeia* weatherized

by

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Bachelor of Design, in Architecture
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Submitted to the Department of Architecture in Partial Fulfillment of the Requirements for the Degree of

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Abstract

In The Architecture of the Well-Tempered Environment, Reyner Banham discusses the architect's obsession with creating self-contained environments that are defined by the enclosure that definitively separates the inside from the outside. What would the shift from architecture as singular interior environments to architecture as dynamic environments that change in response to environmental conditions, mean for design? Can architecture be a working system that modifies, conditions, and controls the environment (heat, light, moisture, and color) to act as materials that shape the space?

Thesis Supervisor: Andrew Scott

Title: Associate Professor of Architecture

Thank you

To my committee:
Andrew, for your time, interest, and advice through this whole process;
Shun, for your sense of humor and words of wisdom;
and Paul, for making the time for this, taking trips to Boston, for your support during the past four months, and the last nineteen years.

To Alex Atwood, for all of your help in those final hours.

To my husband, Michael, for everything, because without you I wouldn't have made it to this point.

To my mom, for believing in me and giving me every opportunity to become who I am today.

To my family and friends for your support and love during the past seven or so years. Thanks for sticking around!

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Hygeia *

weatherized

* Hygeia refers to an ideal city designed around health, put forth by Benjamin Richardson [Hygeia: A City of Health]
Hygieia is the goddess of health, cleanliness and sanitation in Greek and Roman mythology.

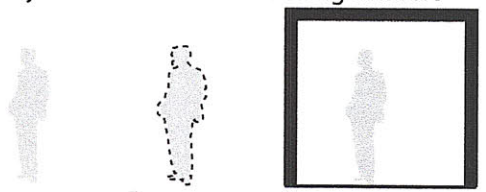
Weather

In the book The Architecture of the Well-Tempered Environment, Reyner Banham discusses the architects' obsession with creating self-contained environments that are defined by the enclosure that definitely separates the inside from the outside. These perfectly tempered spaces don't respond to program. The goal of this thesis is to shift from architecture as a singular interior environment to an architecture of dynamic environments that shift in response to changing environmental conditions.

Can architecture be a working system that modifies, conditions, and controls the environment (heat, light, moisture and color) to act as materials that shape space?

In very basic terms, architecture developed as a means for creating protection from weather and other threatening external forces. In our quest for shelter, we have developed more enclosed habitations with tighter boundaries. We have mastered "comfort", mapping out the ideal comfort zone on the Psychrometric chart, and creating mechanical systems to keep our interior environments within that idealized zone of 72 degrees Fahrenheit and 45% relative humidity. In the process of creating an ideal comfort zone for the universal interior environment, we have simplified and normalized our interior climates. Philippe Rahm states that "modernity lead to uniform," which while it has offered the opportunity for super-thin exterior walls, has also lead to a homogeneity of interior climates.

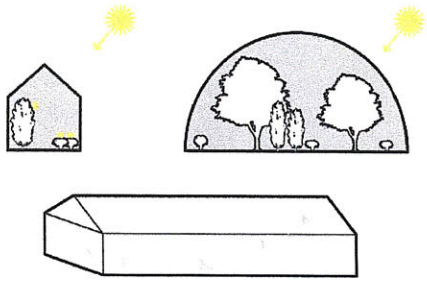
1 layers of enclosure: controlling comfort



"For anyone who is prepared to foot the consequent bill for power consumed, it is now possible to live in almost any type or form of house one likes to name in any regions of the world that takes the fancy. Given this convenient climatic package one may live under low ceilings in the humid tropics, behind thin walls in the arctic and under uninsulated roofs in the desert. All precepts for climatic compensation through structure and form are rendered obsolete."[1]

Man-made weather has allowed for architecture to become what it is today. By gaining complete control of the interior atmosphere, environmental constraints based on the exterior conditions have been eradicated. "Mechanical systems to control and create interior climates materialized between the nineteenth and twentieth century to compensate for the reduced weather protective qualities of architecture."[2] The development of heating abolished the need for the central hearth, while the ability to mechanically heat and cool a building made it possible to have thin walls made of modern materials, such as glass. This, in turn, led to the separation between inside and outside, as the interior 'artificial' environment had to be sealed in so that it would not leak to the exterior.[3]

2 creation + control of extreme environments



[1] Banham, p. 187

[2] Mayer, -arium, p239

[3] ibid.

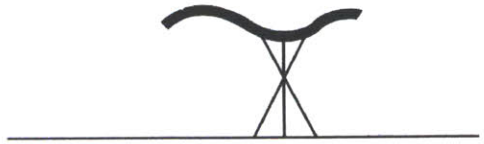
3 layers of comfort: zones of use

This thesis will explore the liberation of the interior from a sealed, homogeneous environment. Reyner Banham states that we "lack a range of spatial experience and cultural responses"[4] that people have always enjoyed. We are "bounded and contained, limited by walls, floors and ceilings."[5] Banham explains this theory with an analogy of a campfire: The campfire is a central focus around which people focus their activities. The "external boundaries are vague, adjustable according to functional need."[6] Varying degrees of heat, light and smoke create different environmental conditions for which a variety of uses can be distributed according to need, and can change as needs and conditions change.

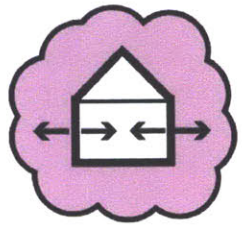
Philippe Rahm, a contemporary designer, is currently exploring the architecture's relationship to space, time, seasons, climate and atmosphere. His mantra "form and function follow climate" is visible in his design explorations, which have been formed from climate and meteorological typologies such as convection, radiation, air pressure, evaporation, and conduction. I propose an architectural project that creates a series of environments which offer a variety of climatic qualities that shift and change according to exterior weather conditions. The building should be flexible and be able to adapt to changing conditions, such as temperature, light, humidity, wind, etcetera. Program should be organized, like the campfire, across environmental gradients based on function and comfort.

4 degrees of mediating thresholds

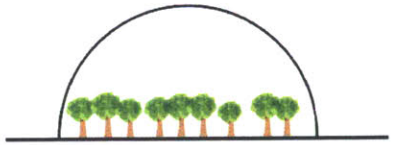
"natural" landscapes: uncontrolled



pavilion (basic shelter): semi-controlled, partial protection



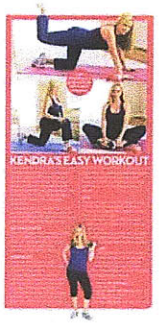
closed building: separation between interior and exterior to control extremities

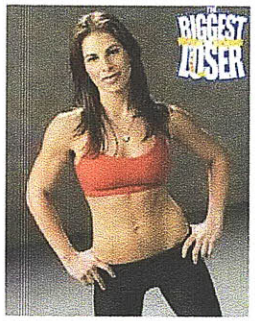


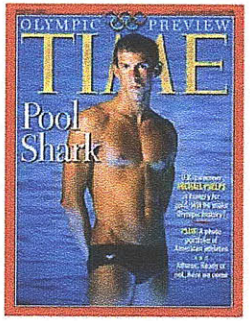
biosphere: extreme environmental control to create and maintain completely new ecosystem / environment

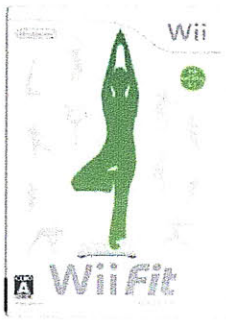
[4] Banham, p19
[5] ibid. p20
[6] ibid.

Wellness:
the Body









If you take a survey across the landscape of popular culture, the obsession with fitness and image is evident; from popular tv shows like Biggest Loser, to popular video games such as WiiFit, and a whole slew of stars heading their own workout routines, including Playboy Bunny and Hugh Hefner's ex-girlfriend: Kendra. The desire for the image of youth, fitness, health and sexuality has become evident in the trend towards fitness centers and spas, routines such as yoga and pilates, and healthy lifestyles that focus on organic foods and products. Surprisingly though, these obsessions are not new, nor have they developed out of our popular culture obsession with movie starts and television. Our focus on body image originates from a biological basis: we strive to display physical and psychological traits through "fitness indicators," which are our way of advertising ourselves as good mates, to ensure survival through the production of offspring.

Our obsessions with image can be traced back to basic biological instincts for survival. As Geoffrey Miller discusses in Spent: "Humans evolved in small social groups in which image and status were all-important, not only for survival, but for attracting mates, impressing friends, and rearing children. Our vast social-primate brains evolved to pursue one central social goal: to look good in the eyes of others."[1] Humans need to be desirable to other humans. In order to accomplish this, we have a series of signals, known as "fitness indicators," that flag our individual traits and qualities so that others can judge us as a potential mate, rival, predator, parent or kin. "The fitness indicators are advertising fundamental biological traits such as good genes, good health, and good social intelligence."[2]

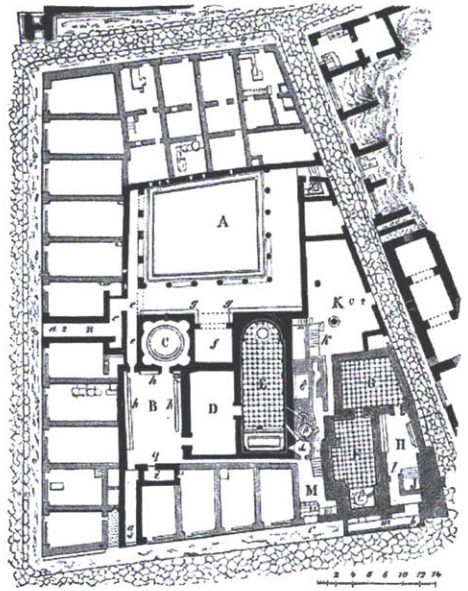
Humans aim to groom these positive traits, to make themselves more desirable to the other sex: men work out to increase the size, quantity, and definition of their muscles, while women groom themselves to have smooth, clear skin, shiny hair, and a tight, fit body with curves in just the right places. Fitness is a key factor, as well as health, for health effects your skin, hair, eyes, and body. Cleanliness is another important factor in desirability. It is these reasons that bathhouses have played such an important role in successful cultures throughout history.

[1] Miller, Spent, p1
[2] ibid. p13

Wellness:
the Bath

The origins of the bathhouse are twofold: in some cases they originated as places for worship or for ritual, and in others they developed from a communal necessity for cleanliness. Baths were public and were shared between community members, but were often limited to the same social class, a specific religious sect, or specifically male or female. Public baths were important civic amenities for many cultures, and although they differed somewhat, they all shared the need for cleanliness, ritual, and community: there was early public bathing in the Mohenjo Daro in the Indus Valley (present day Pakistan) around 2000 BC, the baths of ancient Greece and the Thermae of ancient Rome, the Japanese Sento and Onsen, Turkish Hammams, Scandinavian saunas, North American sweat lodges, and Russian banya. They are each a mixture of bathing, ritual, socializing, necessity and luxury. These baths were much more than a necessary part of life: they were "cornerstones of their cities' spatial forms and their citizens' daily rituals"[3]. They were a place of "beautification, hygiene, healing, socializing, and amusement."[4]

The popularity of public bathing waxed and waned over time, according to outbreaks of plagues and diseases, sexually transmitted diseases, as well as the increasing need for cleanliness because of overcrowding of growing cities. Some say the thermae of Imperial Rome were the cultural peak of public bathing in Western Europe, which were developed from Greek bathing practices.[5] The Greeks introduced washbasins and bathtubs to their gymnasiums for relaxation and personal hygiene, and believed that some natural springs provided healing qualities to cure disease. The Romans developed their Thermae to a new level of size and extravagance. One would enter the atrium after paying an entrance fee, and gain access to the palestra, the central court for exercise: running, weight-lifting, wrestling, and swimming; after which he was covered in oil and scraped with a strigil to clean off the dirt; then one would move to the apodyterium, the changing room, where he could undress and change into sandals to protect feet from the heated floors; from here he could proceed from



Plan of the Old Baths at Pompeii. (Overbeck.)

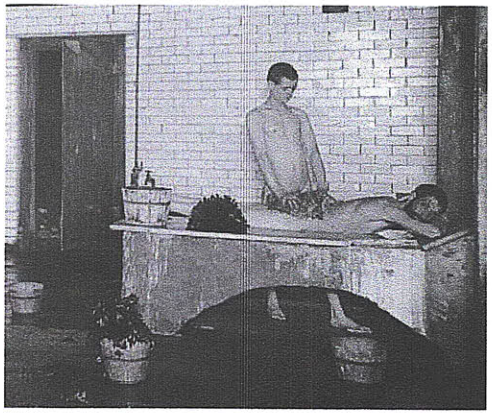
[2] Christie Pearson, The Public Bath and the City http://alphabet-city.org/issues/water/articles/the-public-bath-and-the-city

[3] ibid.

[3] Wikipedia

the tepidarium, the warm bath, which was the largest and most extravagant of the baths, to the caldarium, the hot bath, and the frigidarium, the cold bath, for a quick plunge; after the plunges, one could enjoy the sudatorium, or the moist steam bath, and the laconicum, dry steam bath like that of a sauna, where he could rest and sweat; beyond that were many ancillary spaces for other activities that would keep one occupied for the remainder of the time: rooms to enjoy eating food, booths that sold perfumes and oils, libraries, and reading rooms. Although they tried to segregate the baths, many were mixed-gender.

A bathhouses embodies rituals of purification, which lead to a state of freedom: "Mary Douglas, in Purity and Danger, describes dirt as a cultural construct and as matter out of place. Cultural rituals intended to purify - to separate filth from cleanliness - constitute 'creative movement, an attempt to relate form to function, to make unity of experience,' she writes."[6] There are a series of rituals that are unique to the setting of the bathhouse. The act of disrobing upon entry is the first step: it places you as an active participant in the collective, instead of a detached spectator. It is an equalizing act, whereby stripping yourself of your clothes and jewelry, you get rid of objects that signify social class. "...everyone wearing the same towel, in the



same color, on the same part of the body. There was no status consciousness in the social-stratification sense; the towel or loincloth created a sort of equal-status social group."[7] The second act is the immersion in water: this is a cleansing act in many cultures, "symbolizing a return to nature, to paradise, or to the amniotic bath from which we are born."[8] This purifying step allows you to leave behind the stresses of the outside world. When you emerge from the water, your senses are awakened, and you are finally prepared to indulge in pleasure. "Our identities lose articulation in our bathing costume, and we become free to re-create ourselves. We could make more of these opportunities to remove or loosen our identities."[9]

The thesis will have to deal with issues of the bath: sensuality, sexuality, and cleansing; interaction with the body; water; moderating elemental qualities, such as hot and cold, wet and dry, darkness and light; "etiquette prescribing degrees of nudity shifts" and rules of contact between sexes; and materials that come in contact with the body, effect the body, create ecstasy or physical pleasure.

[6] Strasser, 7

[7] an ethnographer, Homosexualities, p239, 1979: from Wikipedia

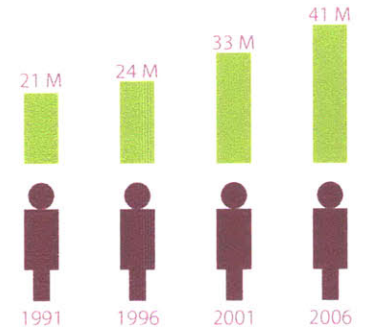
[8] Christie Pearson, The Public Bath and the City http://alphabet-city.org/issues/water/articles/the-public-bath-and-the-city

[9] ibid.

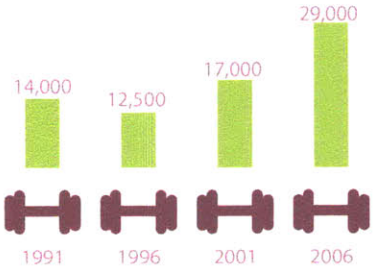
Health + Wellness in the U.S.

The number of Fitness Centers in the US is increasing. This is due to the fact that there has been a decrease in the activity level in work-places over the years, so we have to look for fitness somewhere. In the United States, image is everything. We brand our bodies to market ourselves: our body is our way of advertising ourselves. Consumer Capitalism has set up a system which allows us to purchase the image we display: designer clothes, cosmetics, plastic surgery, organic food, and health clubs are some of the ways we pay to enhance our physical appearance and status. Of these, the health club or fitness center is the most accessible. They range from free, community based organizations paid for with taxes to the ultra-exclusive temples of well-being that can cost upwards of $1,000 per month. But, due to the vast range offered almost anyone can find one in their budget. The explosion of health clubs in America is astounding. Less that 10 years ago only 8% of Americans belonged to a gym of some sort, yet in 2010 that number has more than doubled to 20%, and this number is expected to grow even more. "With over 70 million Americans now ages 6-24, health clubs can expect strong growth in the young adult market over the next decade and beyond."[10] Due to the burgeoning number of gym memberships, the demand for new facilities has increased as well. In 15 years the number has nearly tripled and is expected to continue.

Size of the U.S. Health Club Industry, 2006



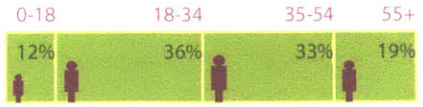
Number of Health Clubs Members in the U.S. by Year



Number of Health Clubs in the U.S. by Year

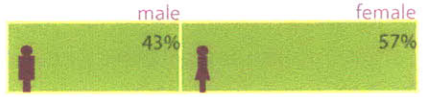
With the increased interest in overall health, there is a developing need for wellness centers. A Wellness Center focuses on overall health, by incorporating the physical benefits of a gymnasium, the restorative effects of a spa, and the healing qualities enabled by a medical facility. They promote healthy living and the prevention, instead of the treatment, of illness and disease. This method of health care is becoming more popular throughout the U.S. and is even being covered by some insurance companies. This allows it to be available to a more diverse group of people, instead of just the wealthy. These centers include many programs, including fitness centers (yoga, weight loss, strength

Health Club Member Demographics, 2005



Age (Median Age 41)

Household Income (Median $61,000)

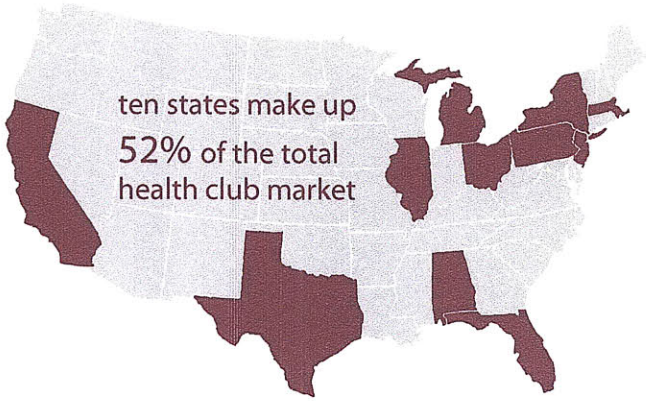


Gender

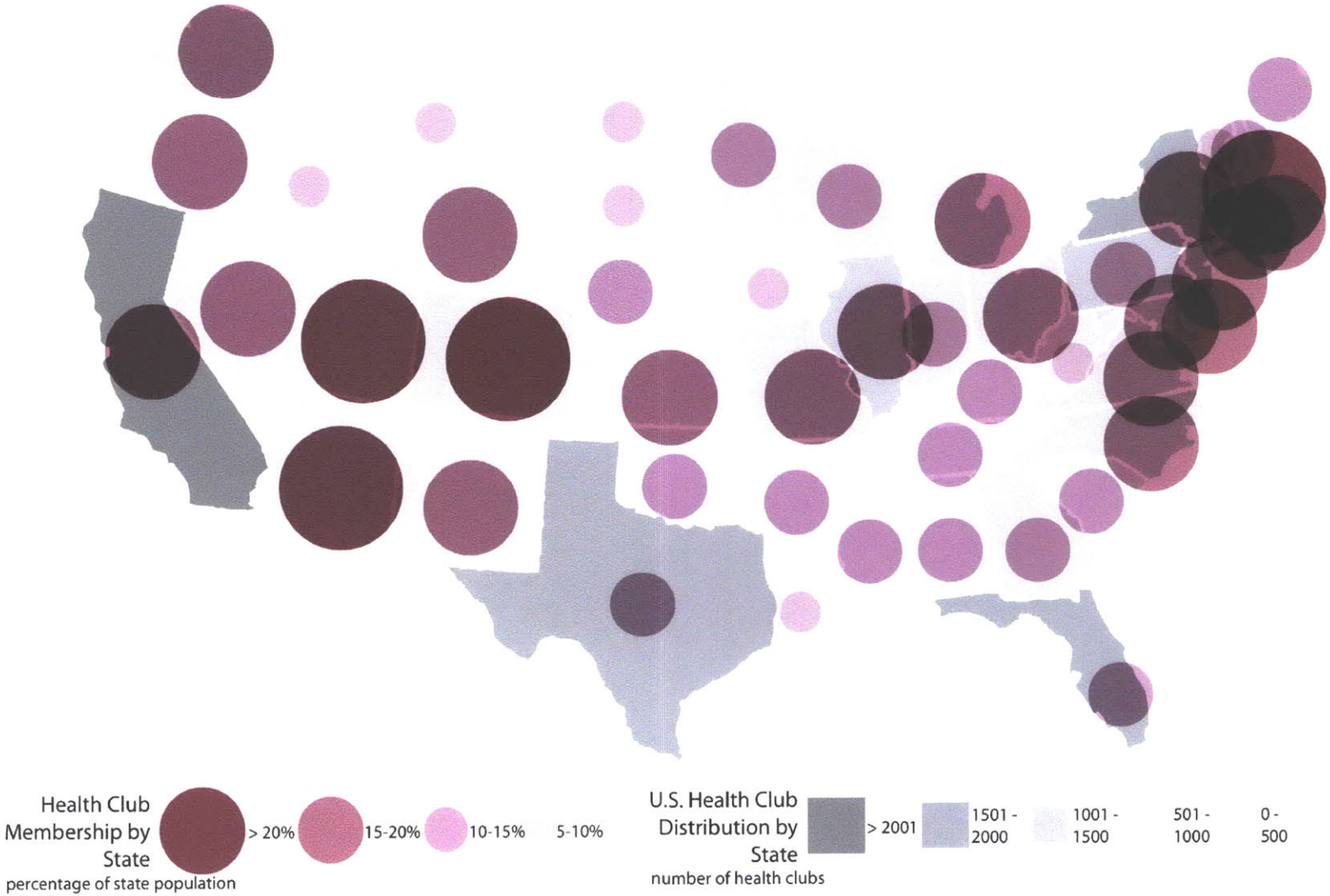
[10] IHRSA, Oct 2002

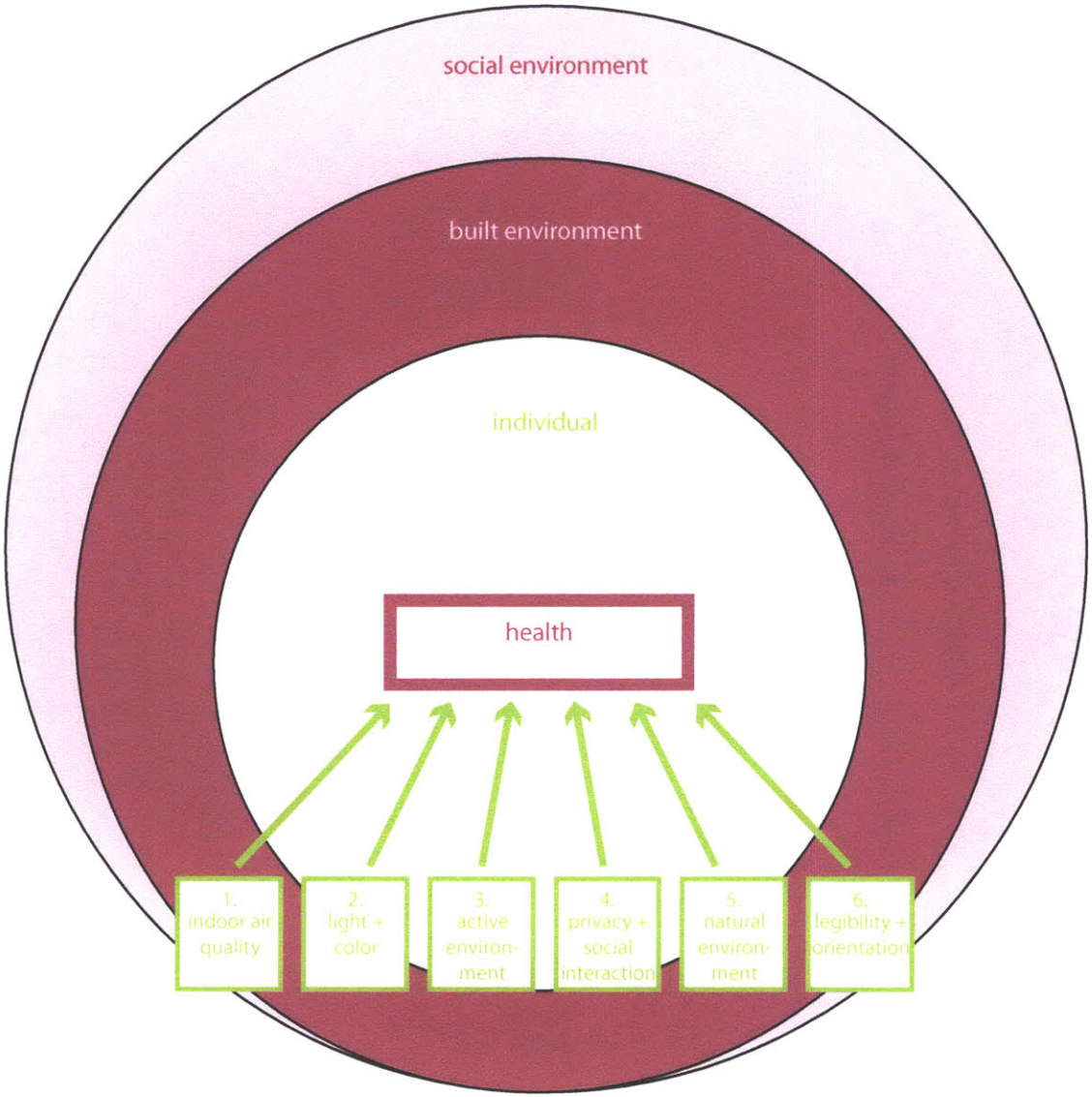
training, general conditioning), spa (for bathing, massage, acupuncture, stress-relief, relaxation), and medical (rehabilitation, health, nutrition, and medicine).

It is imperative that these pieces of program are not simply mashed together and forced into a building, but rather they are combined in such a way that unique juxtapositions create opportunities for pleasure. The Wellness Center and is about the self, the body and soul, finding happiness and joy while creating and tending a healthy lifestyle. It is important that the spatial construct works in conjunction with the program. Rem Koolhaas's views on combination of program is important here: to see it as a "Constructivist Social Condenser."[11] It should be a place that awakens and enlivens the senses; a place that allows you to indulge in any pleasures you desire.



[11] Koolhaas, Delirious New York, p 15


Health Club Membership by State
percentage of state population
> 20%
15-20%
10-15%
5-10%
U.S. Health Club Distribution by State
number of health clubs
> 2001
1501 - 2000
1001 - 1500
501 - 1000
0 - 500



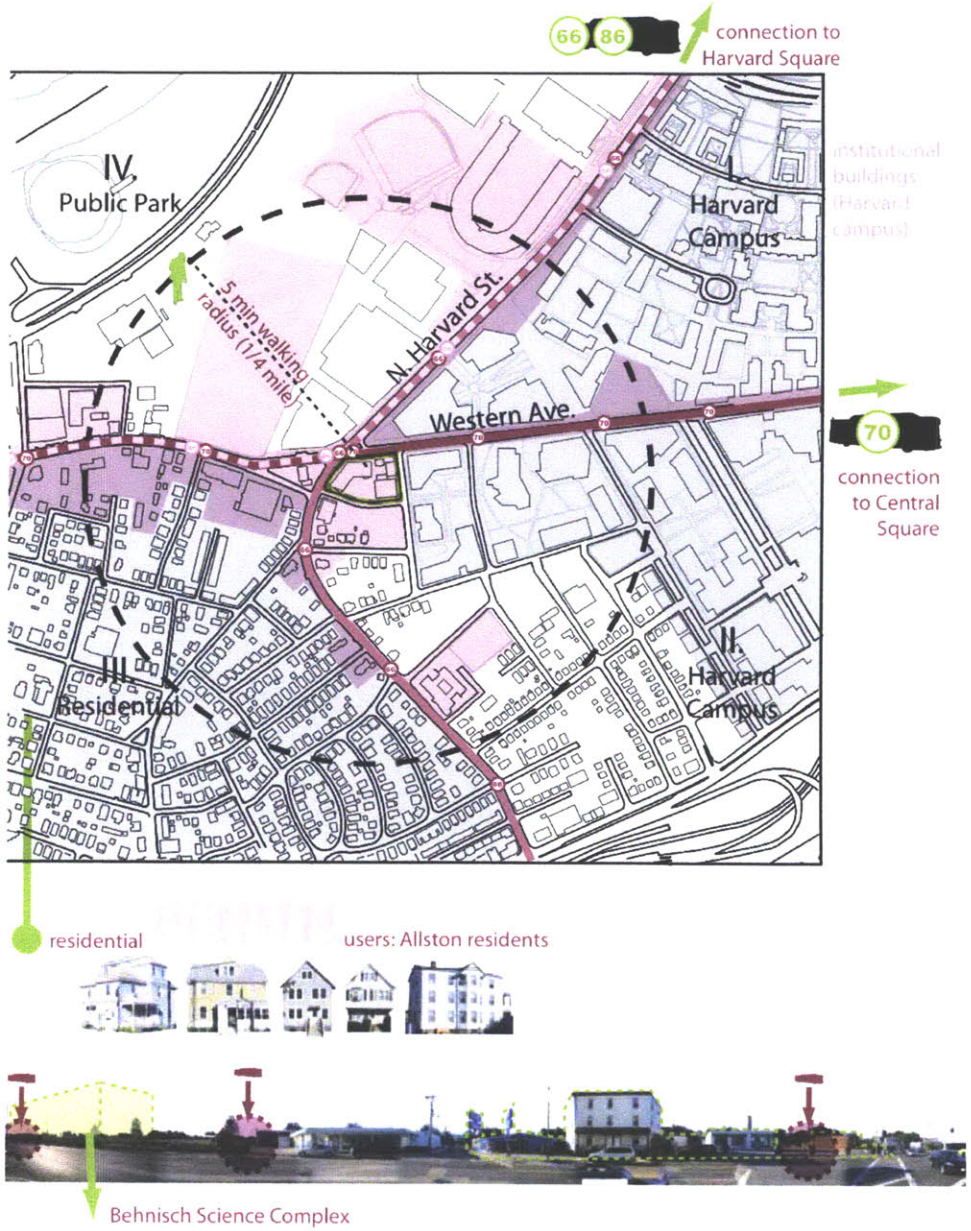
1. indoor air quality:
   - temperature
   - humidity
   - odors
   - contaminants
   - [ventilation]
2. light + color
3. active environment: promotes physical activity
   - connection to public transportation, bicycling, walking
4. provide both privacy + social interaction
   - identify personal private territory
   - social interaction - community life, sense of belonging
5. promotion of natural environment
6. legibility, orientation - sense of place
   (but also stimulate curiosity)

Hygeia* weatherized

The Project Development

The Project Site

The project site is a (nearly) empty lot in Allston, Massachusetts. It is at the edge of the Harvard campus extension and has the possibility/opportunity to become the gateway to Harvard's campus. Likewise, it is also at the gateway to the Allston residential community. It is a corner lot , defined by the two major roads that run through Allston: Western Avenue which runs east-west and connects to Central Square, and N. Harvard St. which runs north-south and connects to Harvard Square. These roads break the area into four quadrants, which each have a unique character and remain divided because of the busy intersection.



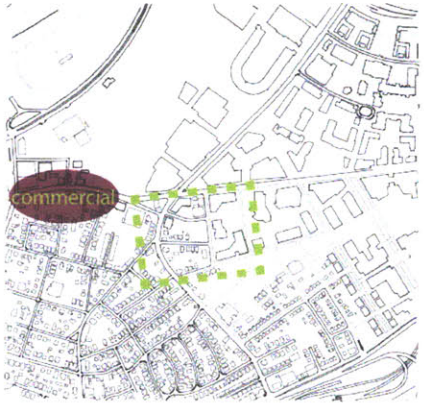
Map of Allston

The Project Site

existing urban fabric: 1-3 family houses (some 4-6 unit houses) + multi-family apartment buildings

Collegiate Architecture: Harvard Business School and extension campus

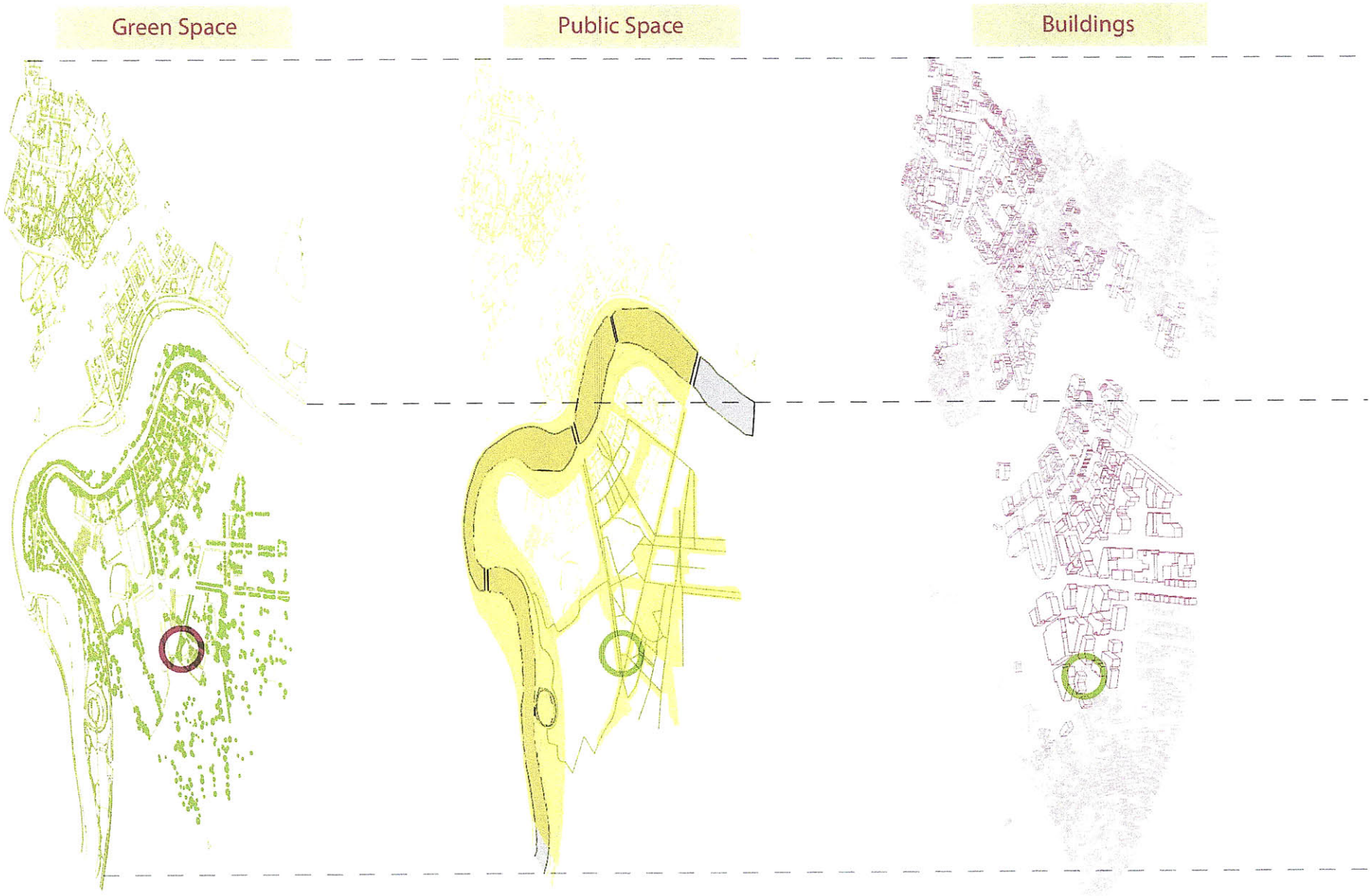
immediate site: Flint cleaners, 7-eleven convenience store, Gulf Gas



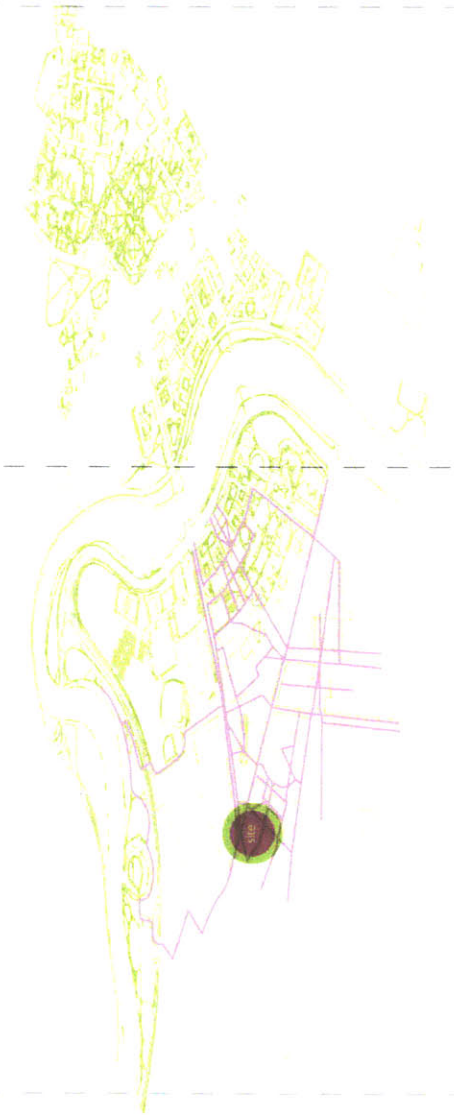
Western Avenue: commercial strip (all asphalt, not pedestrian friendly)

North edge of site: sports facilites (Harvard)

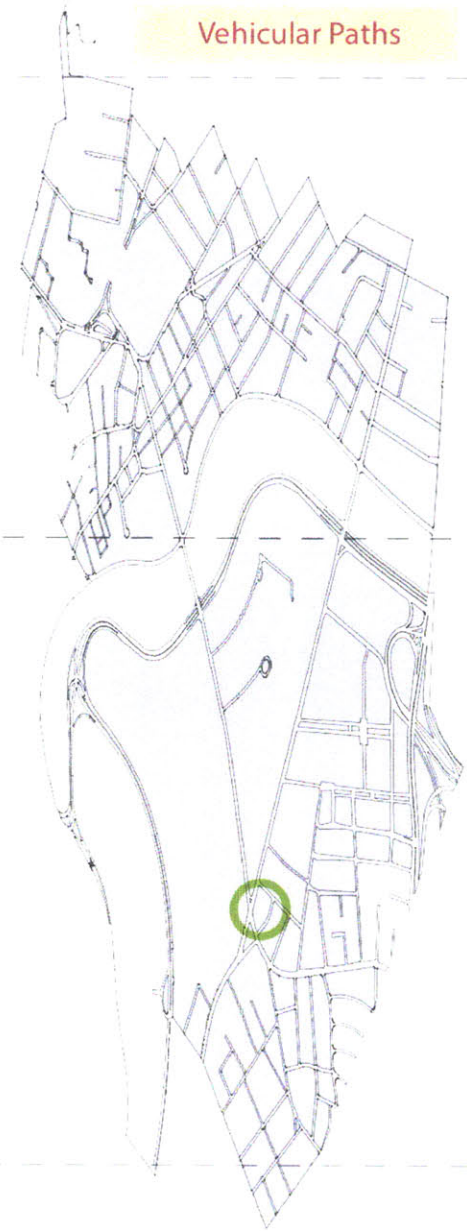
park system along Charles River: pedestrian, bike, and runners


Green Space
Public Space
Buildings

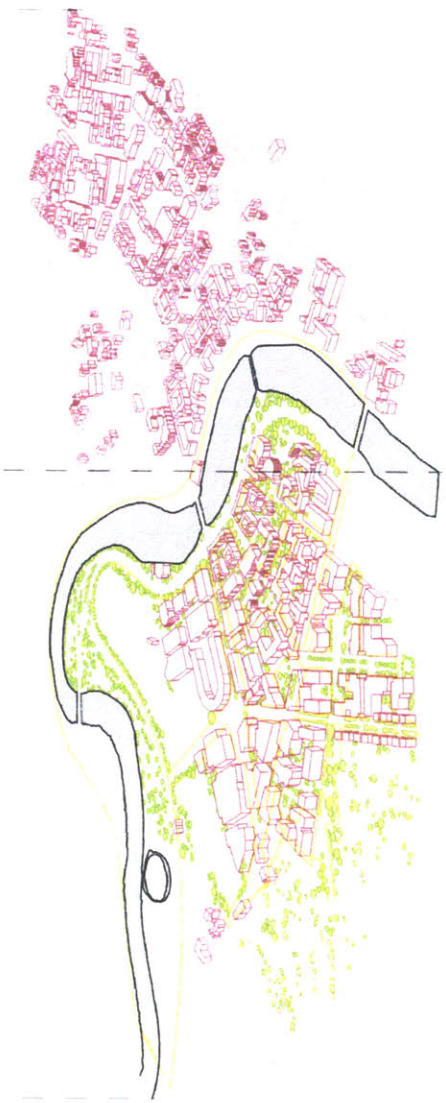
Pedestrian Paths



Vehicular Paths



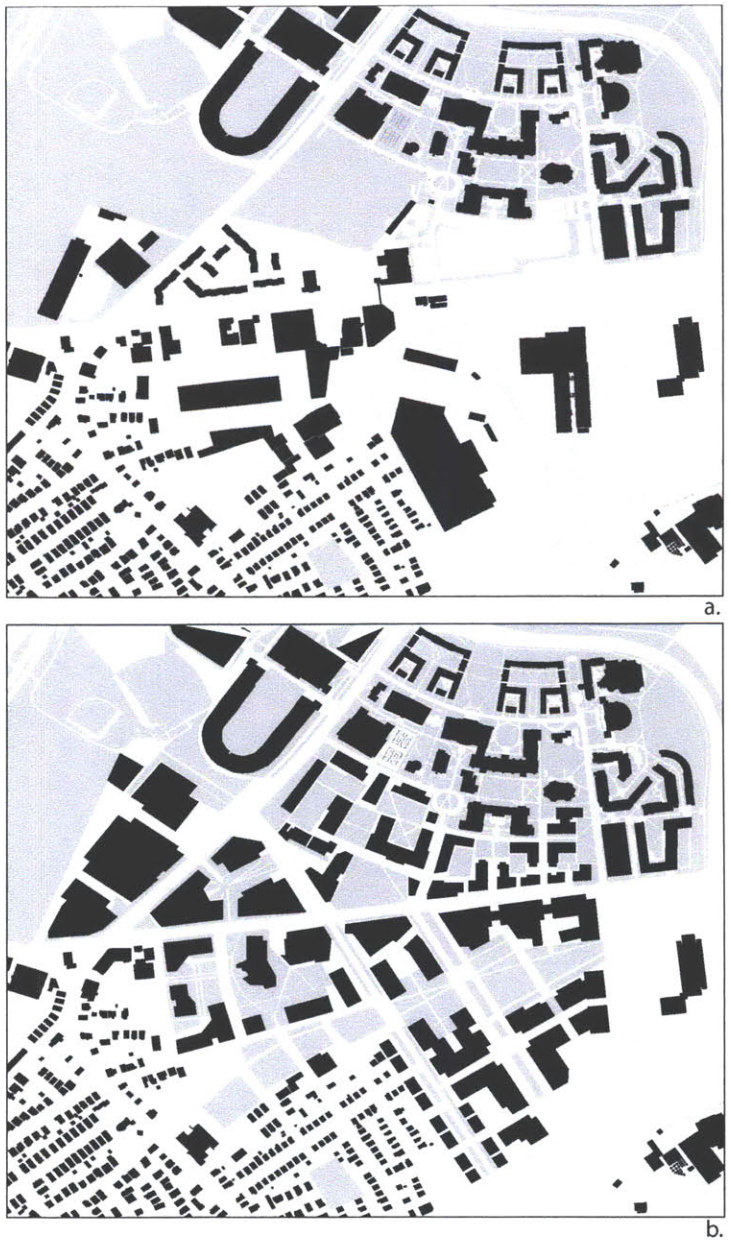
Site



Harvard Expansion

Harvard has an approved Institutional Masterplan for the expansion of the campus into Allston. Harvard's plan for Allston will take decades to realize, but they have started by buying land and bulldozing shops, restaurants, and other local spots along Western Avenue, without offering anything in return to the residents of Allston. This has caused noticeable tension between the Harvard community and the Allston residential community. Since the Co-operation Agreement in 2008, Harvard has been working to strengthen their relationship with Allston by offering community programs and neighborhood enhancements.

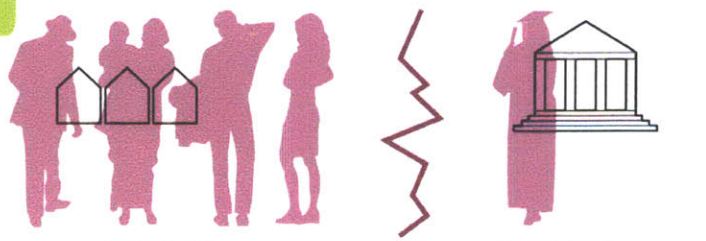
Harvard's current masterplan ends at the Behnisch Science Complex, which is seen as the edge of the campus. These buildings are massive in scale, reaching 7-8 stories, or 120 feet in height. They tower over the 45' houses that they are encroaching on and create a wall dividing the campus from the rest of Allston. The project can use this keystone site as an opportunity to bridge between the campus and the community.



Site Study: figure/ground (a. current; b. Harvard's masterplan)

Map_expansion of Harvard's campus in Cambridge into Allston

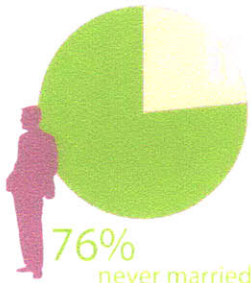
urban edge project



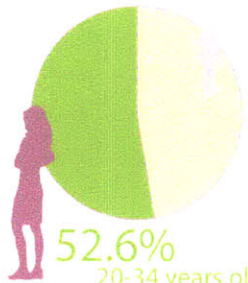
population 20,887

female 49%

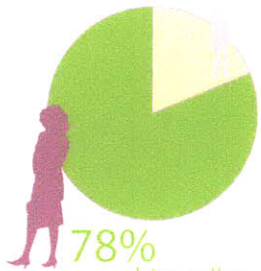
male 51%



76%
never married



52.6%
20-34 years old



78%
white collar

Allston demographics

The Project Program

The project's program is a community center for health and wellness.

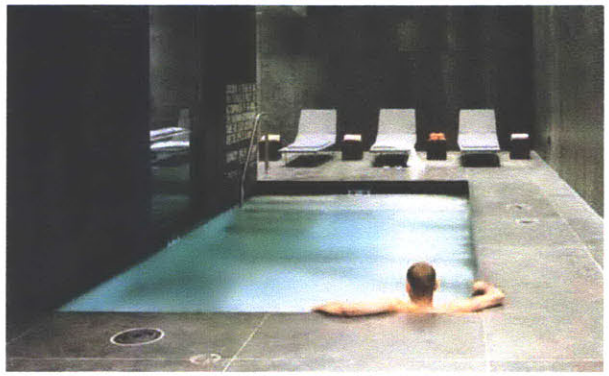
The World Health Organization's (WHO's) definition of health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. According to this definition, the building should not be used as a place to treat illness, but instead a place that offers different activities to create a well-balanced lifestyle, not only physically, but also mentally and socially. The combination of different programs is important to create a dynamic community center that can be used by all ages and types of people. It has three component parts: an aquatics component, a fitness component, and a health component.

World Health Organization's (WHO's)
Definition of **Health:**

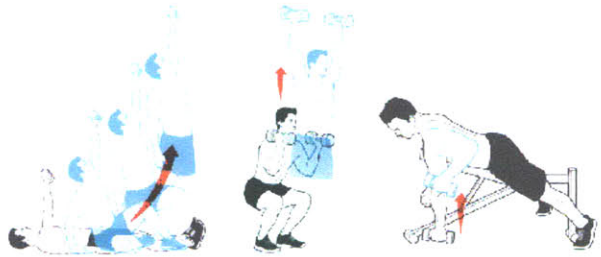
A state of complete physical, mental and social well- being and not merely the absence of disease or infirmity.

Wellness Center

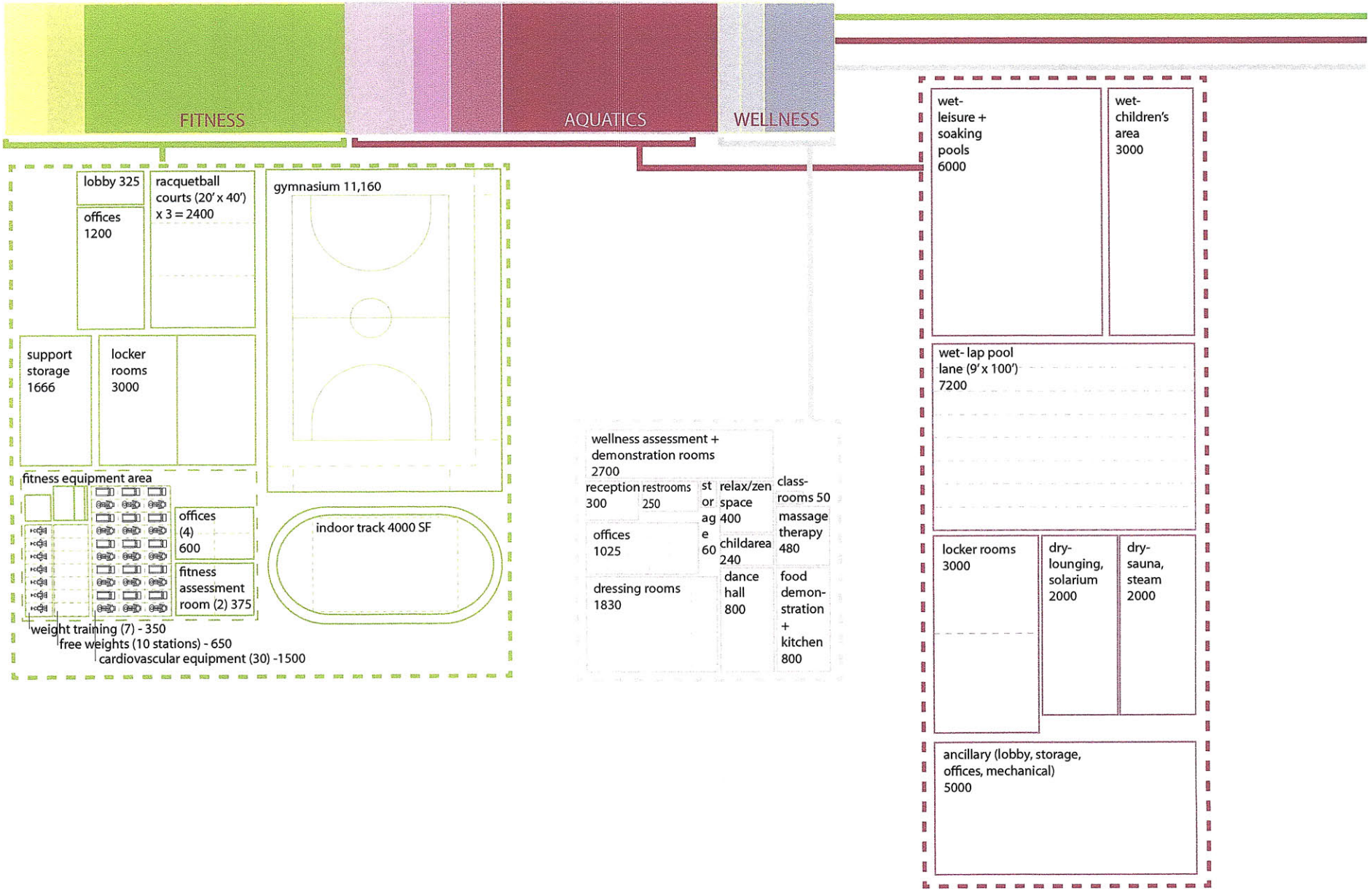
aquatics
- lap pool
- leisure pool
- fun pool
- spa
- sauna
- steam
- solarium
- etc...

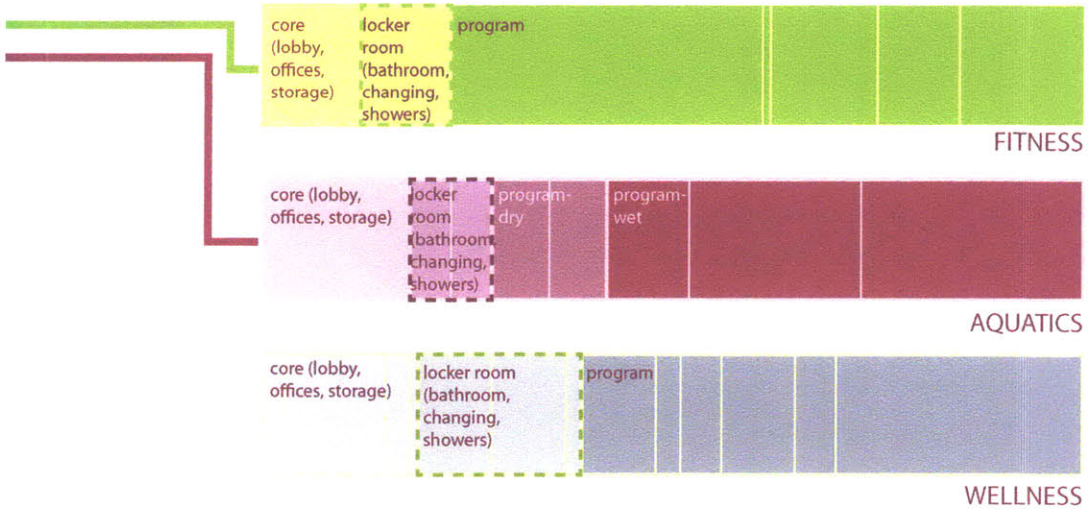


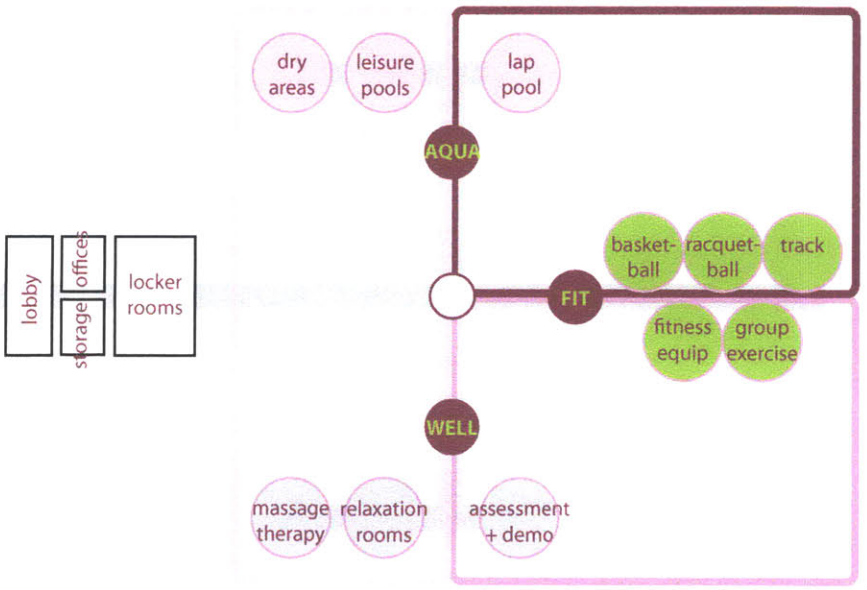
fitness
- weight rooms
- group workout
- basketball court
- racquetball court
- yoga / pilates
- track



health
- massage
- chiropractic
- acupuncture
- nutrition


FITNESS
AQUATICS
WELLNESS
lobby 325
racquetball courts (20' x 40') x 3 = 2400
offices 1200
gymnasium 11,160
support storage 1666
locker rooms 3000
fitness equipment area
offices (4) 600
fitness assessment room (2) 375
indoor track 4000 SF
weight training (7) - 350
free weights (10 stations) - 650
cardiovascular equipment (30) -1500
wellness assessment + demonstration rooms 2700
reception 300
restrooms 250
storage 60
relax/zen space 400
class-rooms 50
offices 1025
childarea 240
massage therapy 480
dressing rooms 1830
dance hall 800
food demon-stration + kitchen 800
wet- leisure + soaking pools 6000
wet- children's area 3000
wet- lap pool lane (9' x 100') 7200
locker rooms 3000
dry- lounging, solarium 2000
dry- sauna, steam 2000
ancillary (lobby, storage, offices, mechanical) 5000

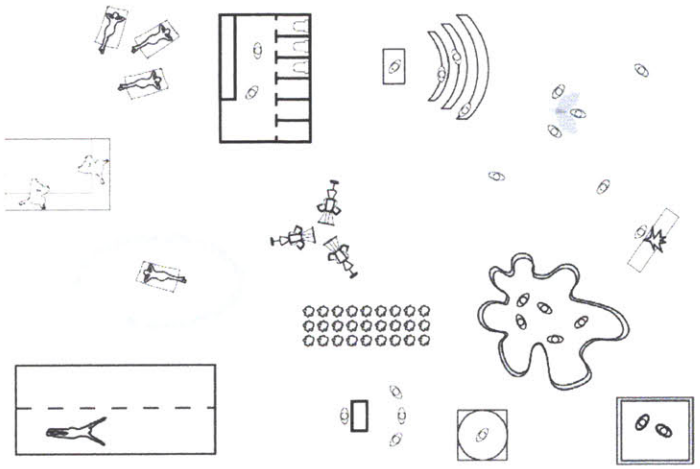


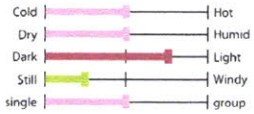
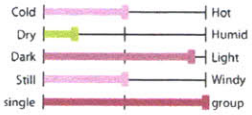
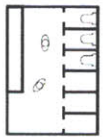
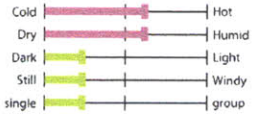
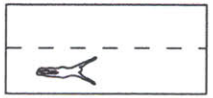
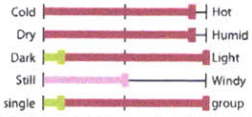
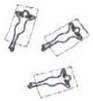
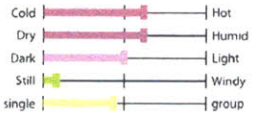
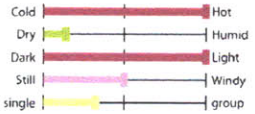
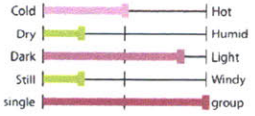
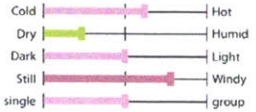
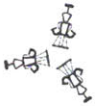
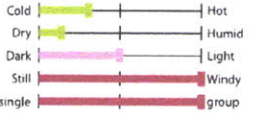
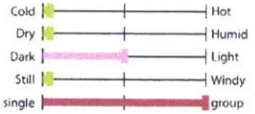
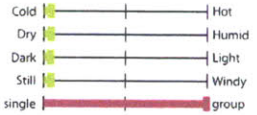


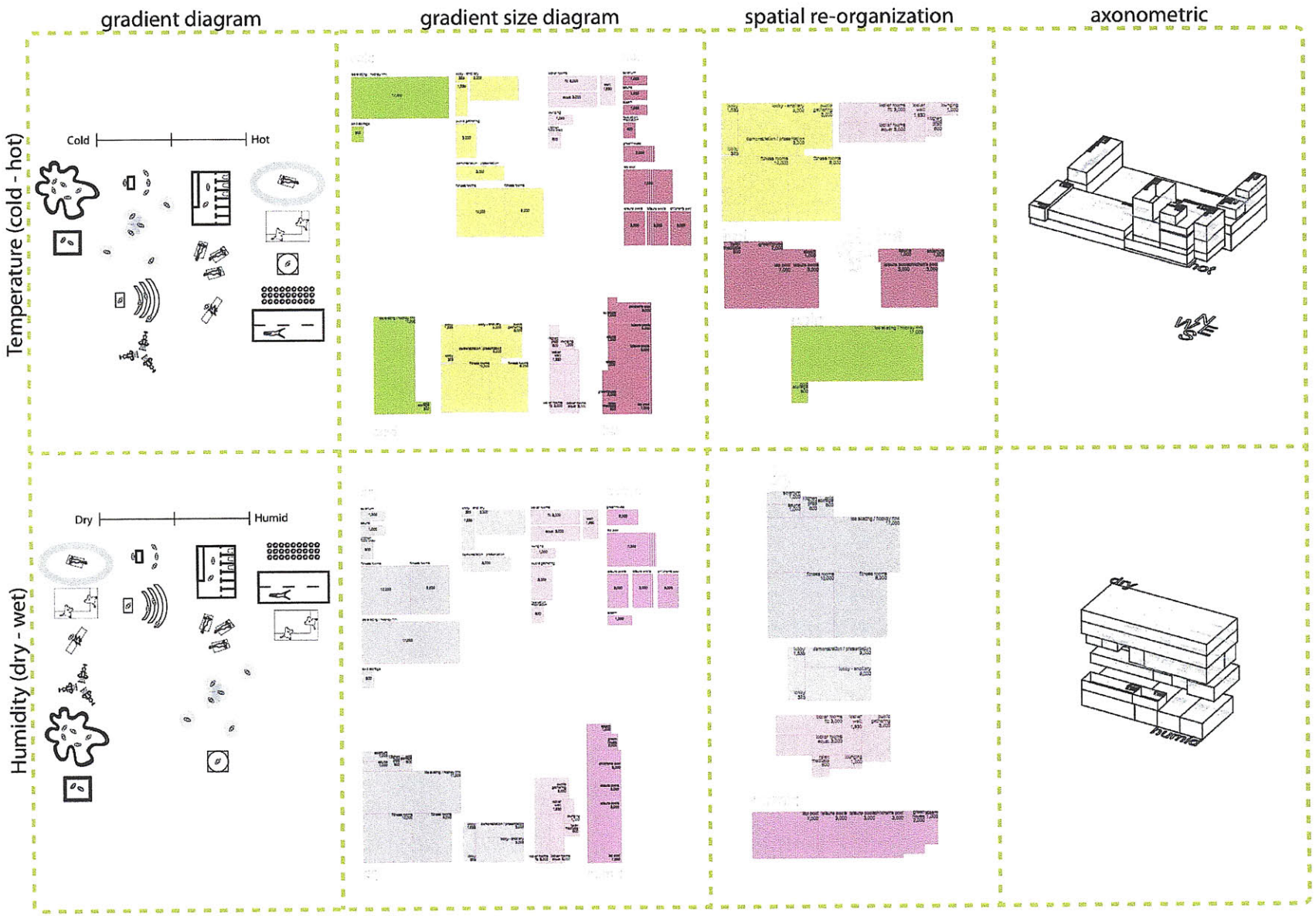
Programmatic organization + square footage

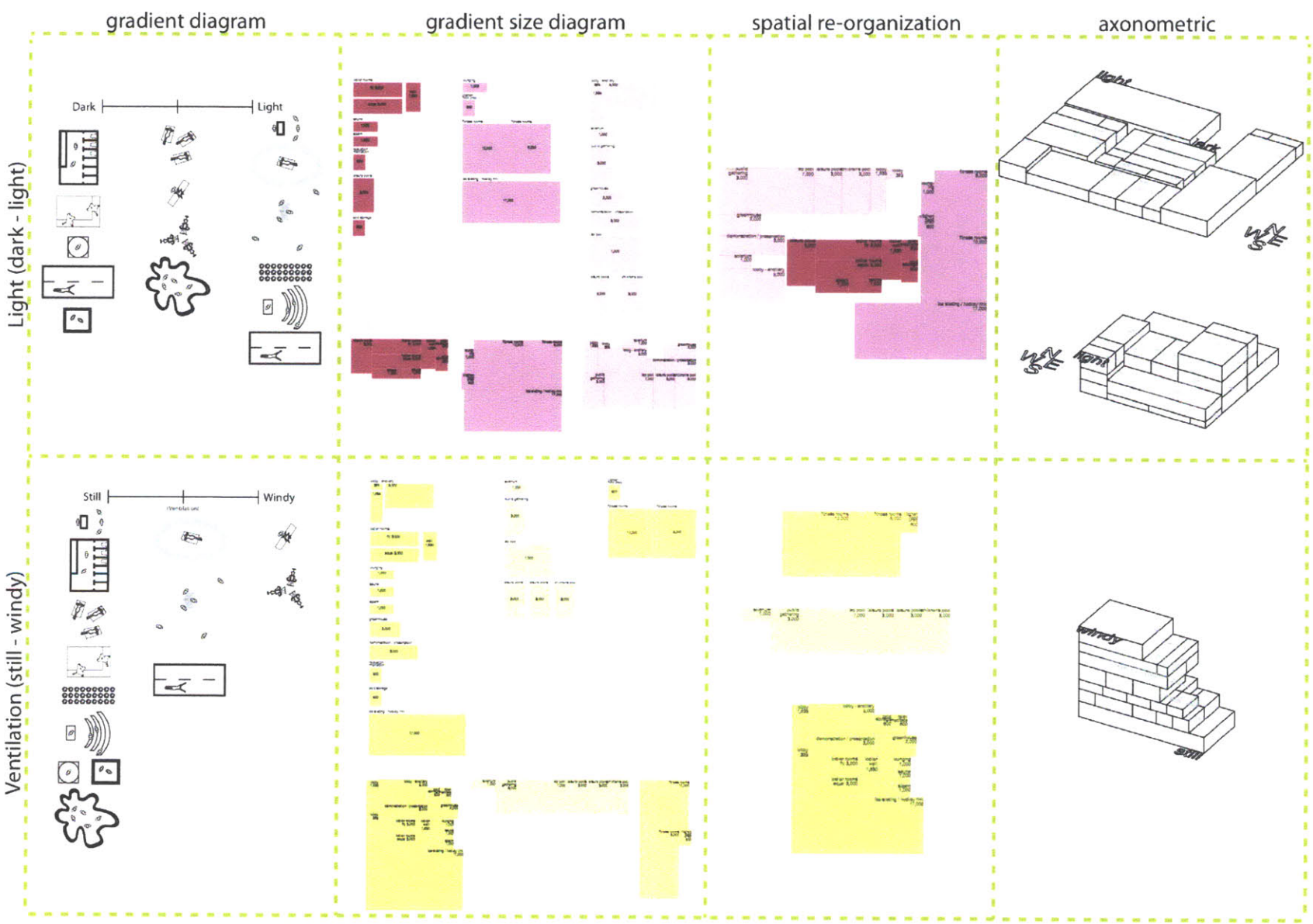
Program Re-Organization

A series of studies were conducted to explore the range of possibilities in re-organization of the program around specific environmental needs. Four basic environmental qualities were chosen (light- dark, light; ventilation- still, windy; temperature- hot, cold; humidity- dry, wet) and each programmatic piece/ element was rated on a range. From there, different programmatic combinations could be arranged based on like qualities.



use	environment	use	environment
 lobby		 public gathering space (banquet hall, dance hall)	
 bathroom / changing / locker		 pools	
 lounging		 greenhouse	
 solarium		 demonstration / presentation	
 sauna + steam		 kitchen / food prep	
 fitness rooms		 cold space- hockey, ice skating rink	
 relaxation / meditation		 cold space- storage	


gradient diagram
gradient size diagram
spatial re-organization
axonometric
Temperature (cold - hot)
Humidity (dry - wet)
Cold
Hot
Dry
Humid
hot
wet
dry



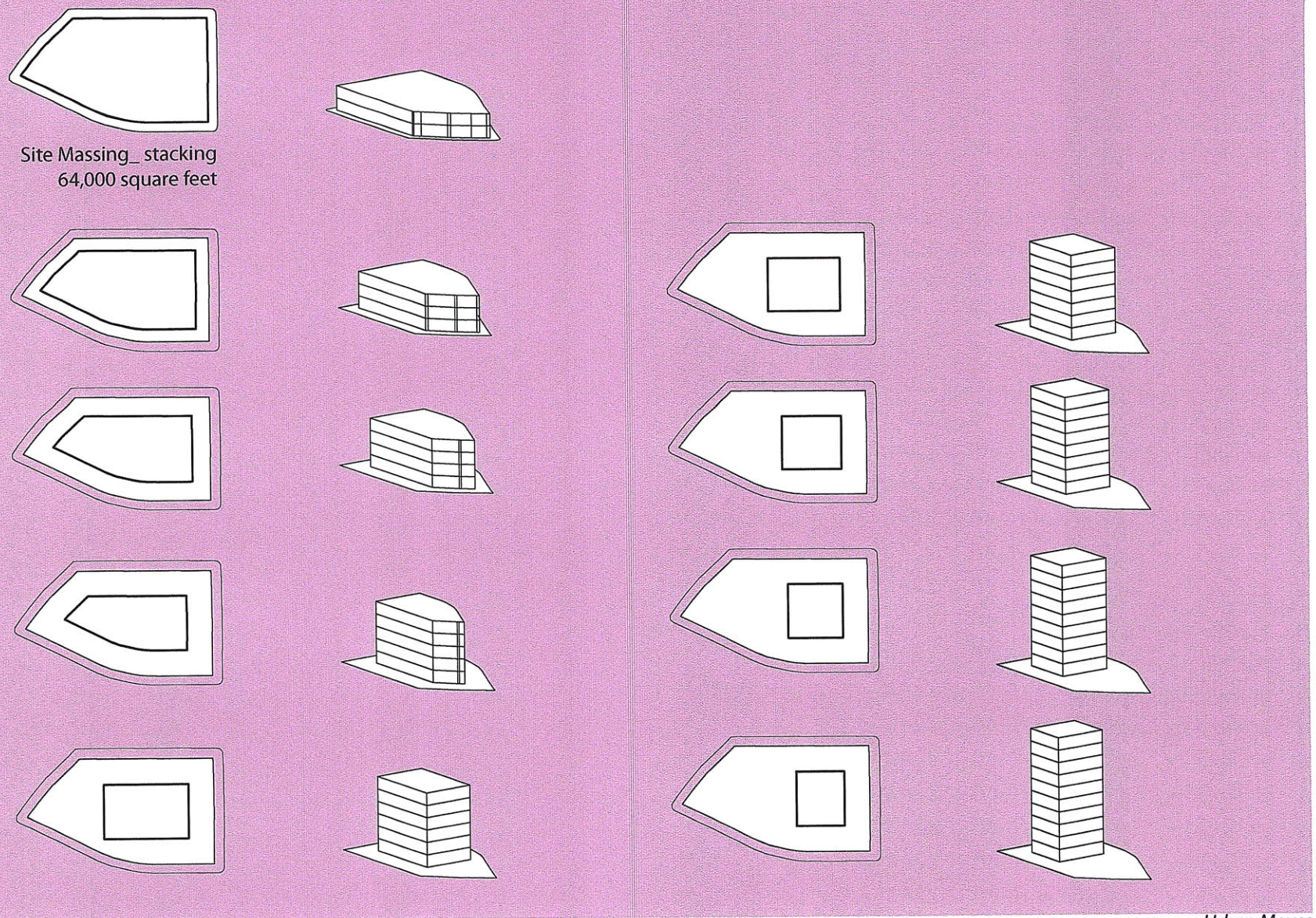
Programmatic organization diagrams

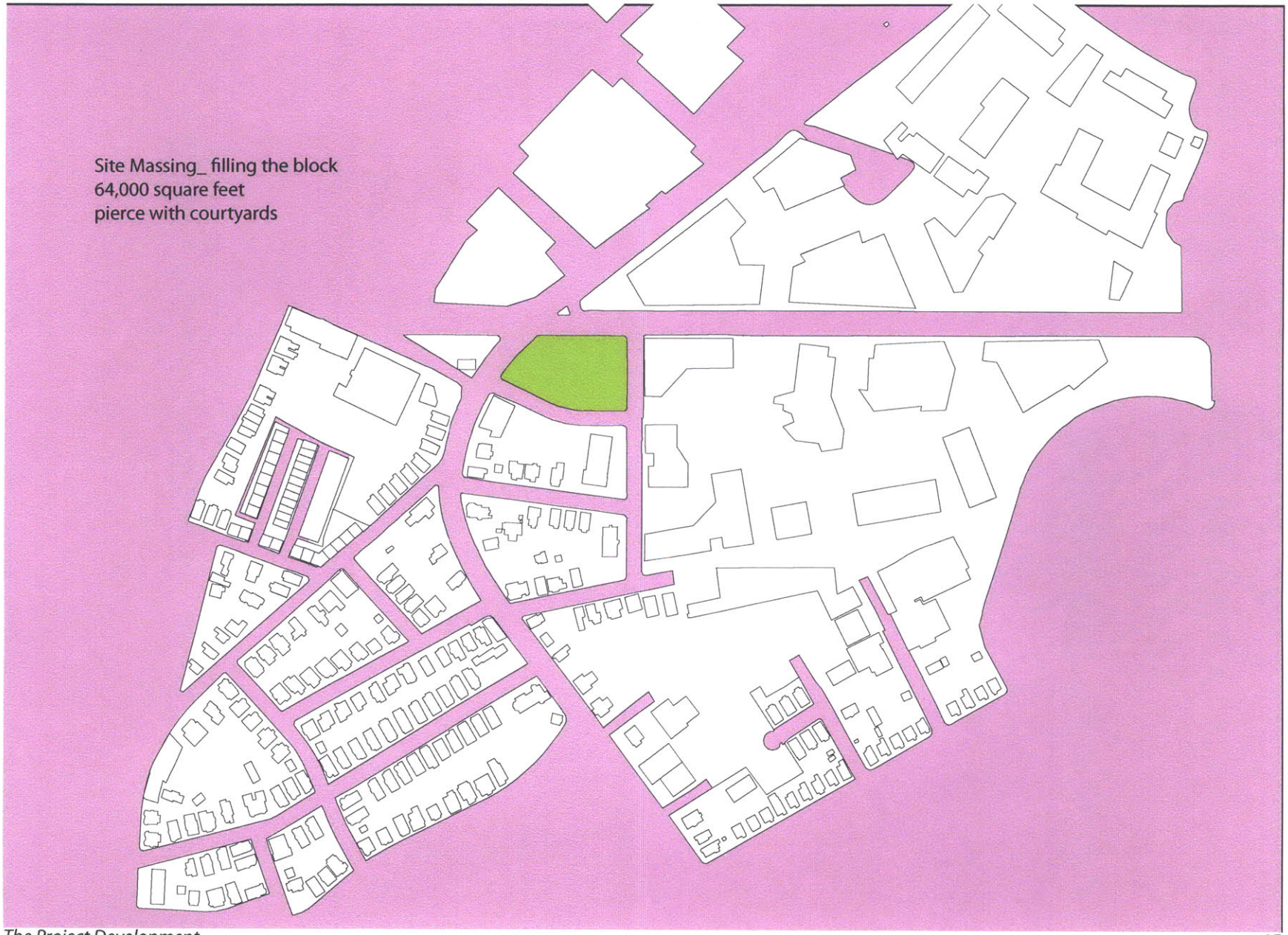
Urban Moves

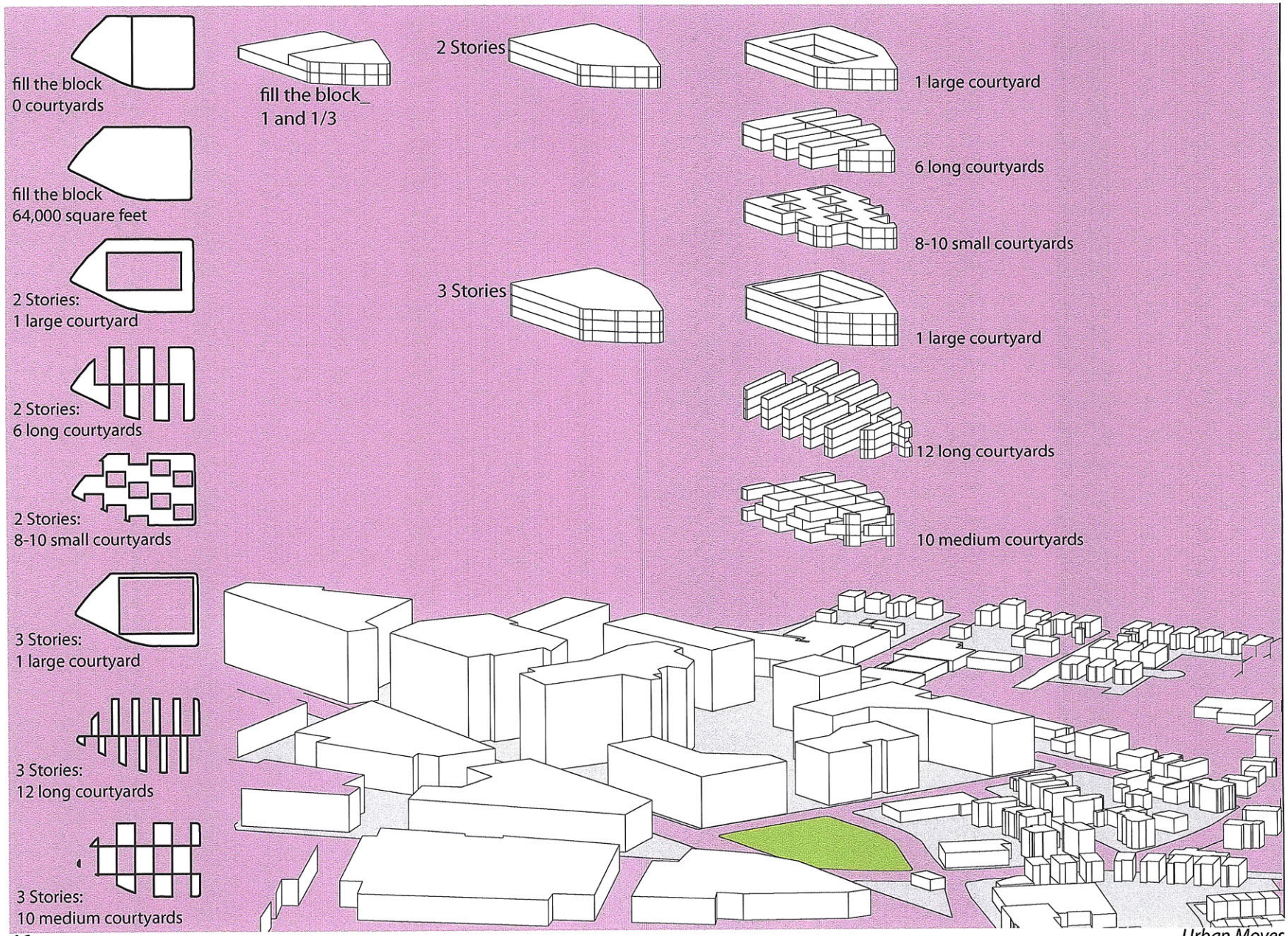
Massing and scale are important issues for this particular site. The scale change between the 7-8 story institutional buildings and the 2-3 story residential buildings make for an interesting challenge. The question becomes how do you mediate between the two? Do you want to mediate, or should the building "side" with one or the other?

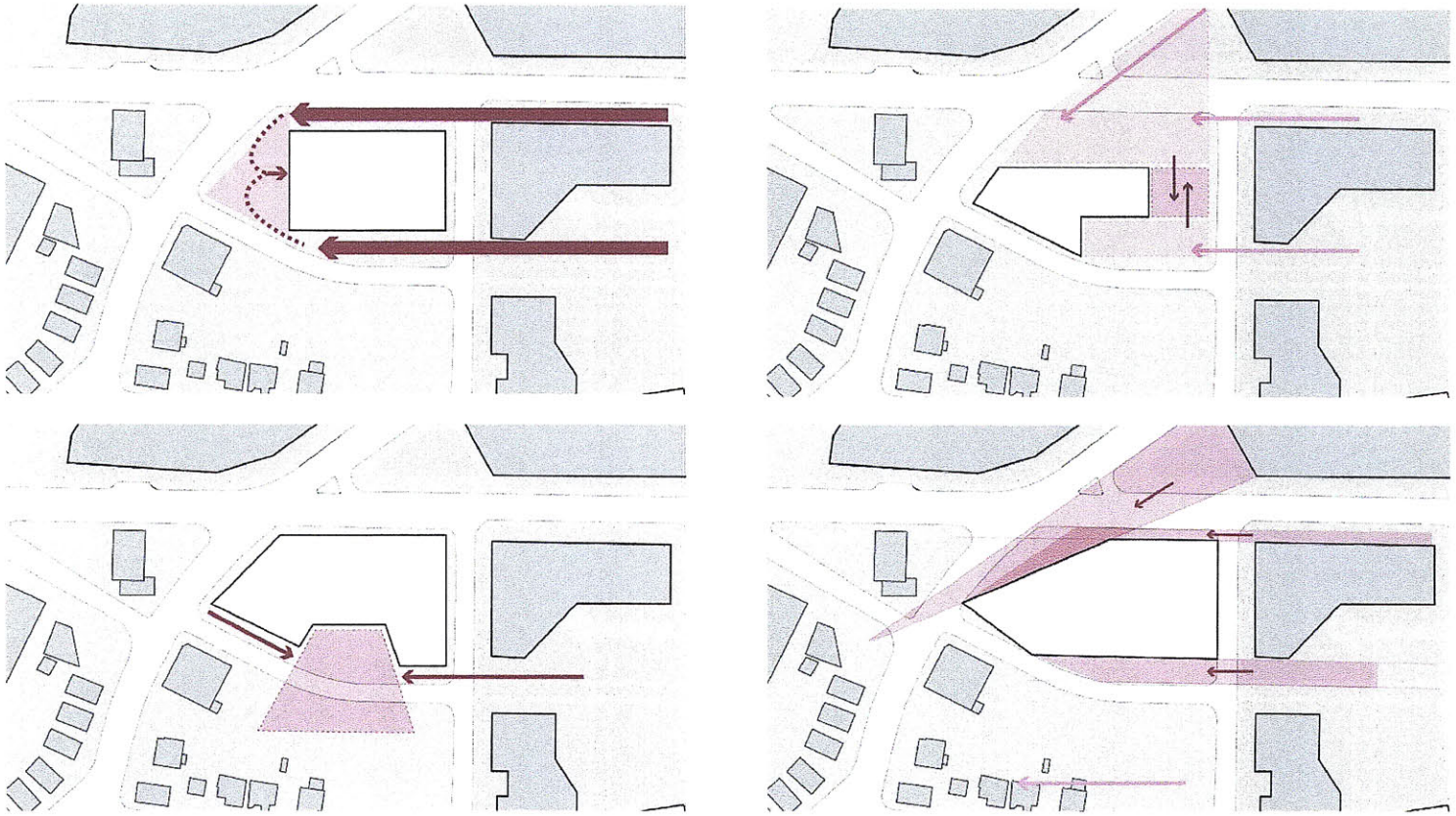
The proposed project is a medium sized building: it is much bigger than the houses, but smaller than the institutional buildings. The site is 64,000 square feet and the programmatic components add up to approximately 80,000 square feet (within the range of 60,000 and 100,000 square feet). The massing studies show that if the site were filled, it would only be a 1-2 story building that would be dwarfed by the Behnisch complex next-door. On the other hand, it could be compressed to tower to 7-9 stories like the Science Complex, but would then leave nearly 75% of the site empty.

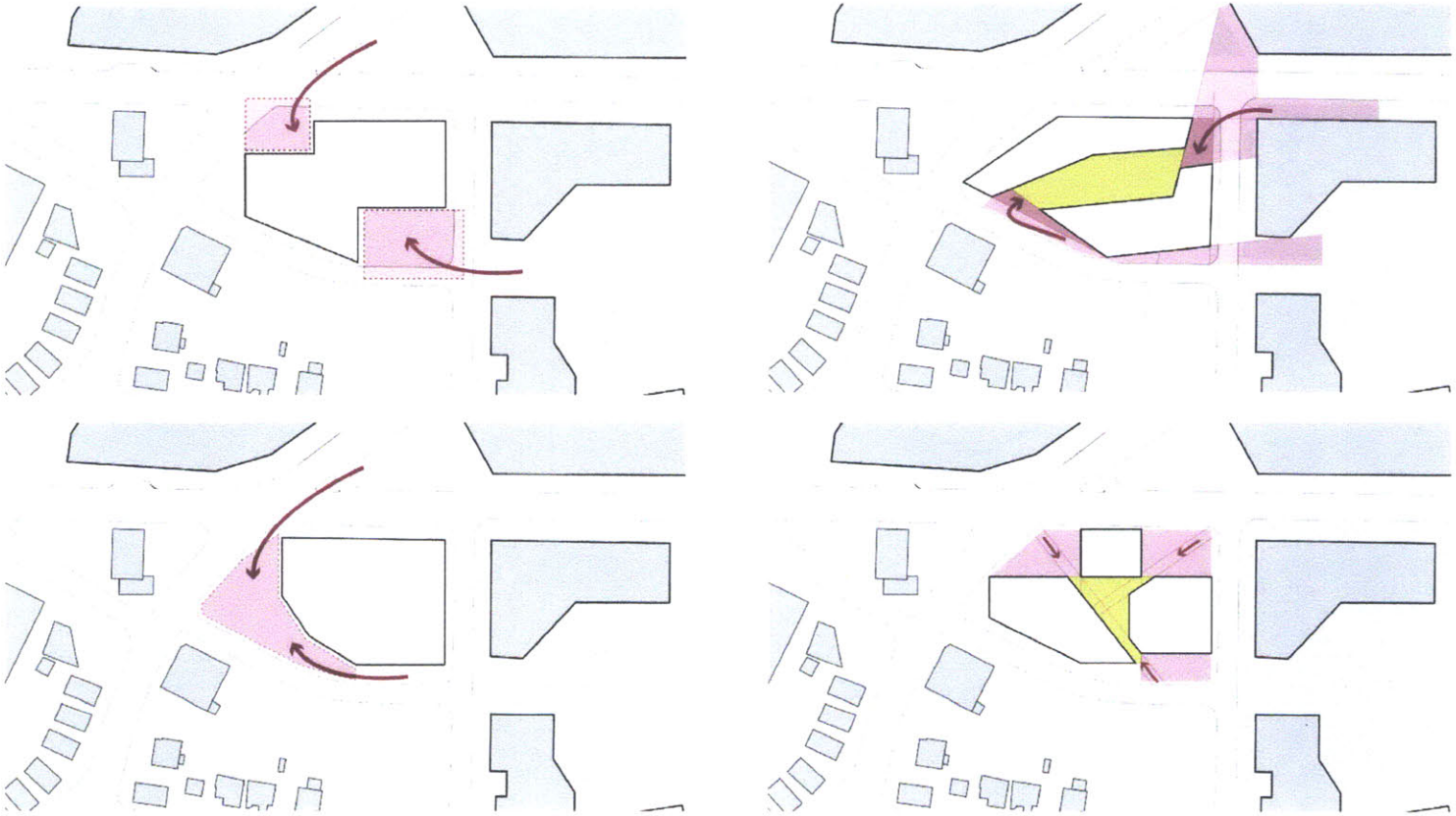
The second series of massing studies explore the use of 'courtyards,' or punctures into the mass, in order to enlarge the overall volume of the project. Because the size of the project is a medium scale, punctures can displace program, resulting in a building that appears bigger. This will allow it to have a larger presence on the site.


Site Massing_ stacking
64,000 square feet

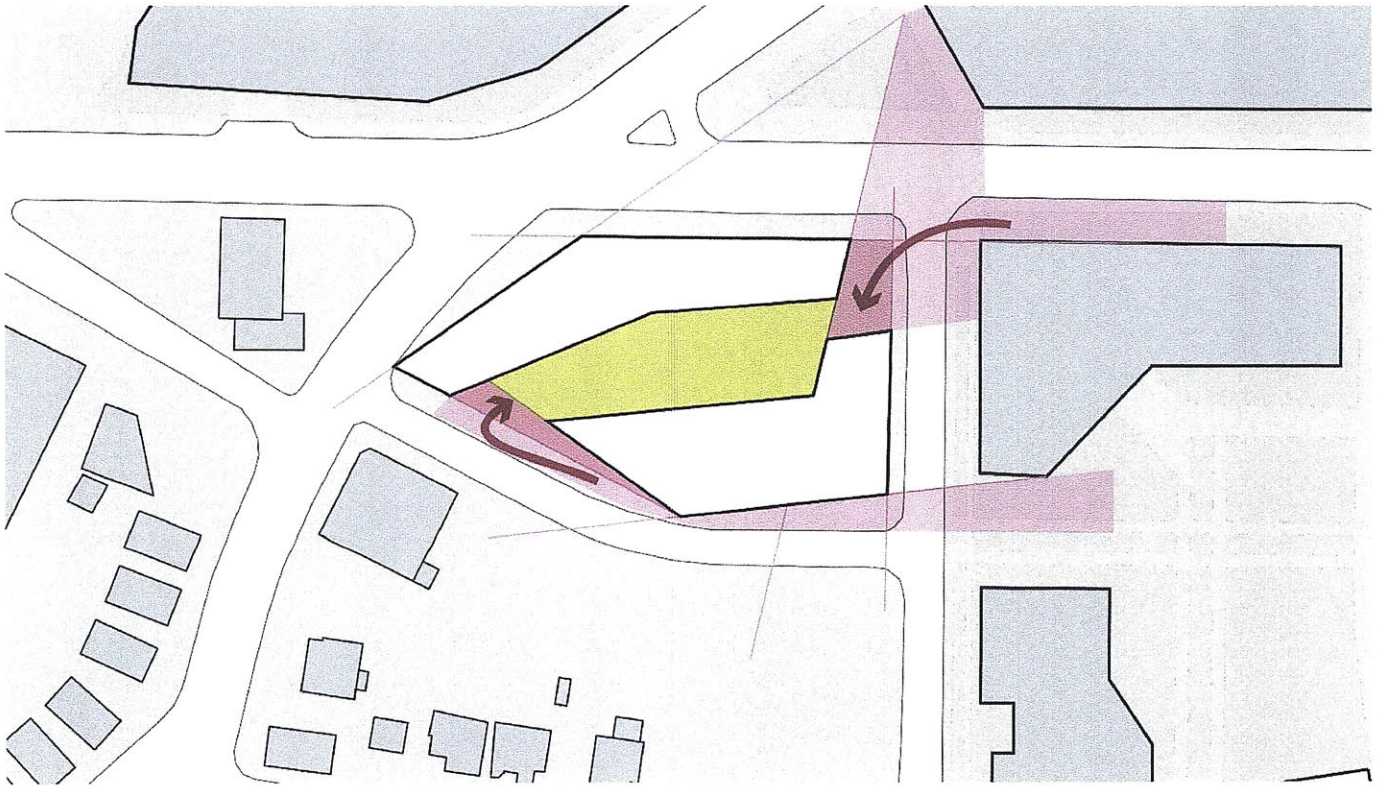

Site Massing_ filling the block
64,000 square feet
pierce with courtyards


fill the block
0 courtyards
fill the block_
1 and 1/3
2 Stories
1 large courtyard
6 long courtyards
8-10 small courtyards
fill the block
64,000 square feet
3 Stories
1 large courtyard
12 long courtyards
10 medium courtyards
2 Stories:
1 large courtyard
2 Stories:
6 long courtyards
2 Stories:
8-10 small courtyards
3 Stories:
1 large courtyard
3 Stories:
12 long courtyards
3 Stories:
10 medium courtyards

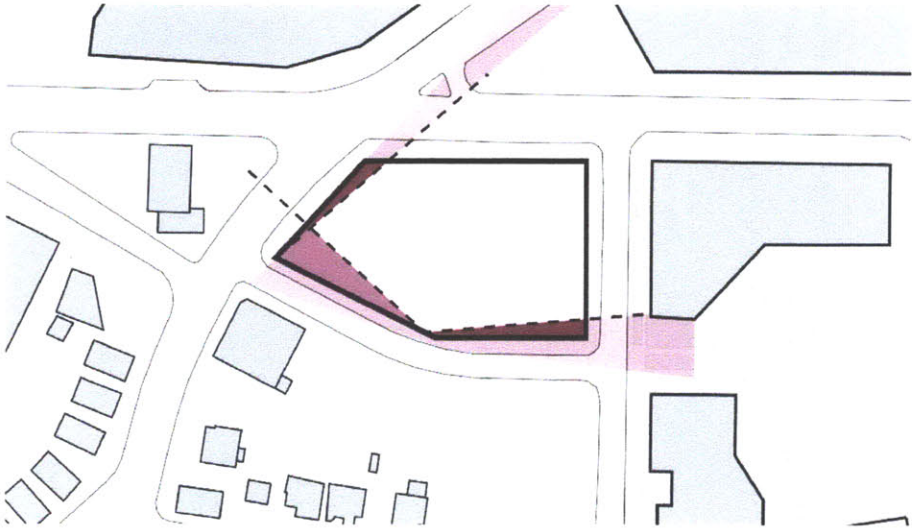




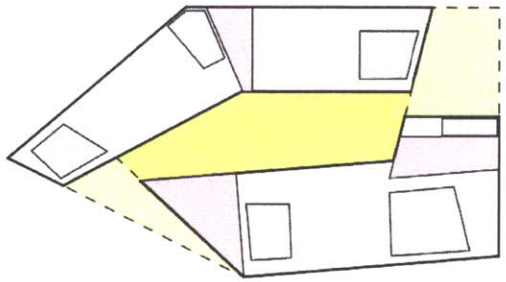
Site flow sketches were used to explore the edges of the site, pedestrian flows, and possibilities for social collectors. As a community building, entry, movement, and public space become important elements of the design. These studies explore the relationship between these elements, and different design possibilities.

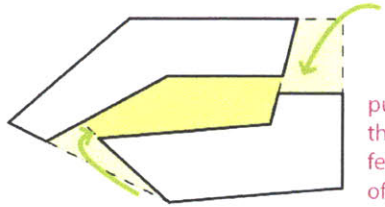


urban diagram chosen to explore further

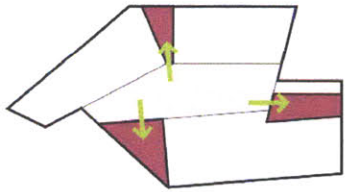


outline of block is offset to create territory of the building; edges are shaved in to connect to pedestrian access

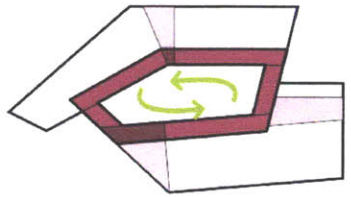




public access nodes in corners of the building
feed into interior courtyard (heart of the building)



vertical circulation extends off of central courtyard / atrium



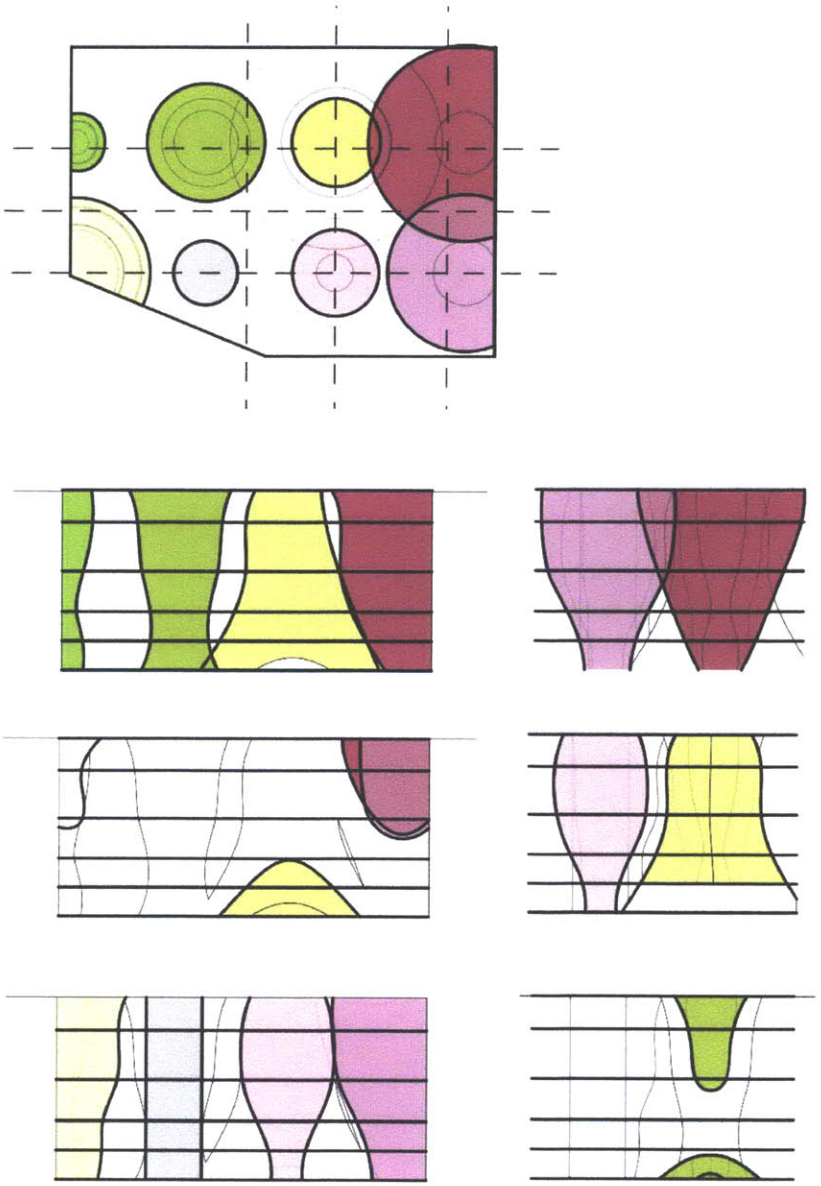
circulation between wedges occurs around the atrium and offers visual connection to other spaces

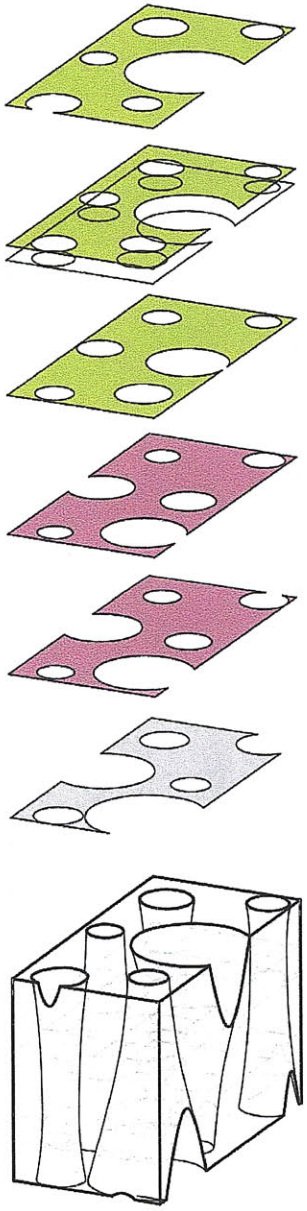
Funnel Development

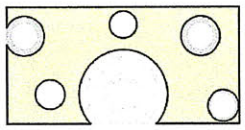
The formal logic for the funnels developed from historical forms that are used to passively heat and cool a building. The solar chimney, or thermal chimney, is a vertical shaft that has been used for centuries throughout the world to increase ventilation in a building. It is a simple form that has a basic environmental principle: stack effect; as hot air rises (and escapes through the top), cool air is drawn in (through openings in the bottom). Each individual solar chimney, or 'funnel', has layers within it with different air temperatures. This offers a way to organize program vertically around temperature differences. These spaces are continuous and naturally create this dynamic environmental condition, so there is no need for walls to separate and control the different spaces.

A series of preliminary studies were used in order to explore the range of environmental differences that could be created in one of these funnels. Could the form of the solar chimney be used to create other conditions, such as holding in moisture, blocking wind, shading from sun, collecting heat, etc? Dimension, opening size, and edge curvature were altered to control the interior conditions.

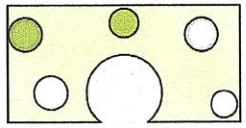
After the preliminary ideas of the funnels were introduced, the question was how to introduce them to the specific site: how many funnels can the site hold? what is the breaking point? how big or small can/should they be?



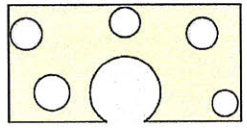




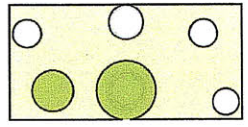
roof



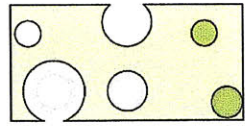
6th floor: aquatics



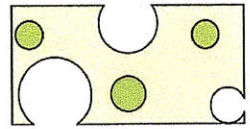
5th floor: aquatics (mechanical)



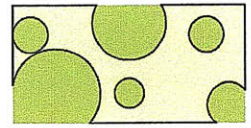
4th floor: aquatics



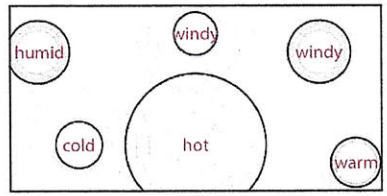
3rd floor: fitness



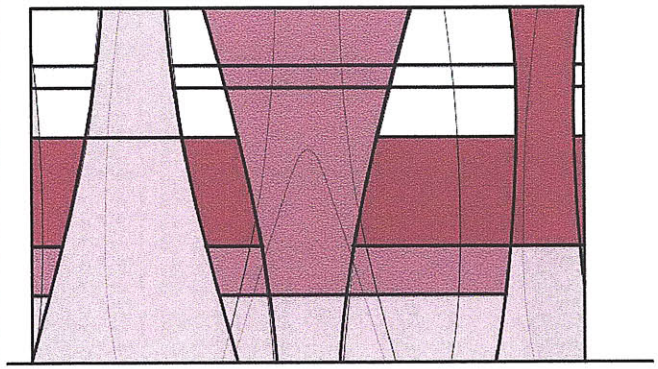
2nd floor: fitness



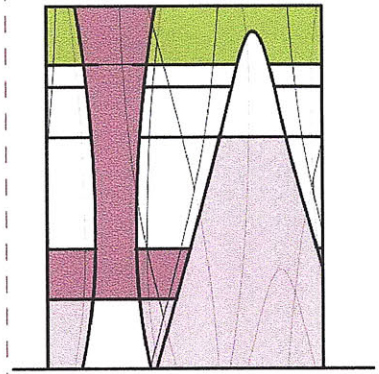
ground floor: entry + wellness

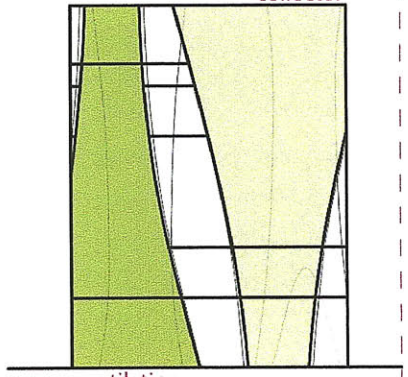


each floor organized by temperature, cones cut through and create a vertical connection between floors and temperatures

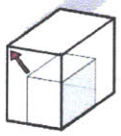


sunny: solar collector





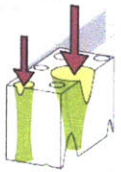
ventilation: stack effect



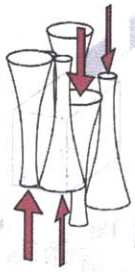
mass expanded to include greater volumes of spaces inside

cones_wind tunnel to ventilate and cool

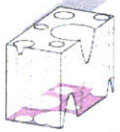
gridded and wells distributed



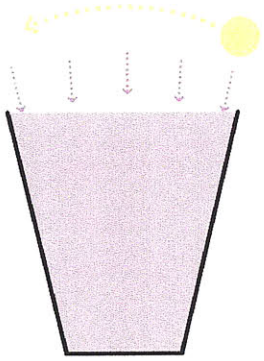
wells_to collect solar (light, heat, energy)



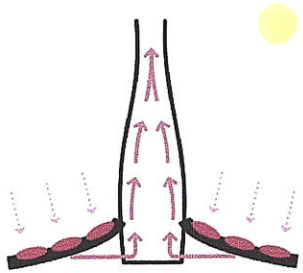
pushed or pulled depending on purpose (temperature)



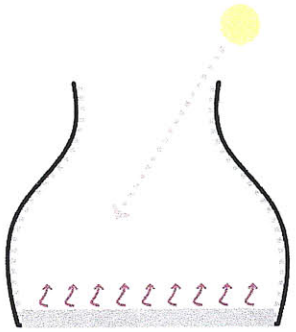
microclimate "bursts" are situated within other program, which circulates around cones and wells



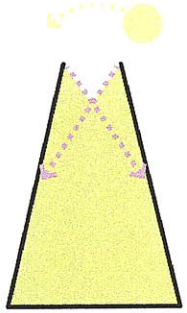
sunny



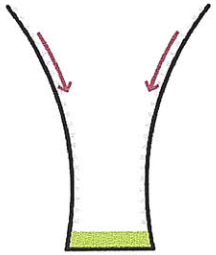
hot



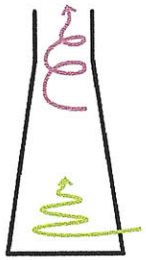
hot humidity



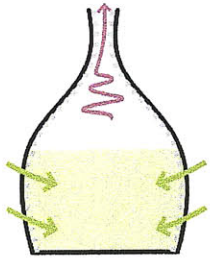
dark



wet

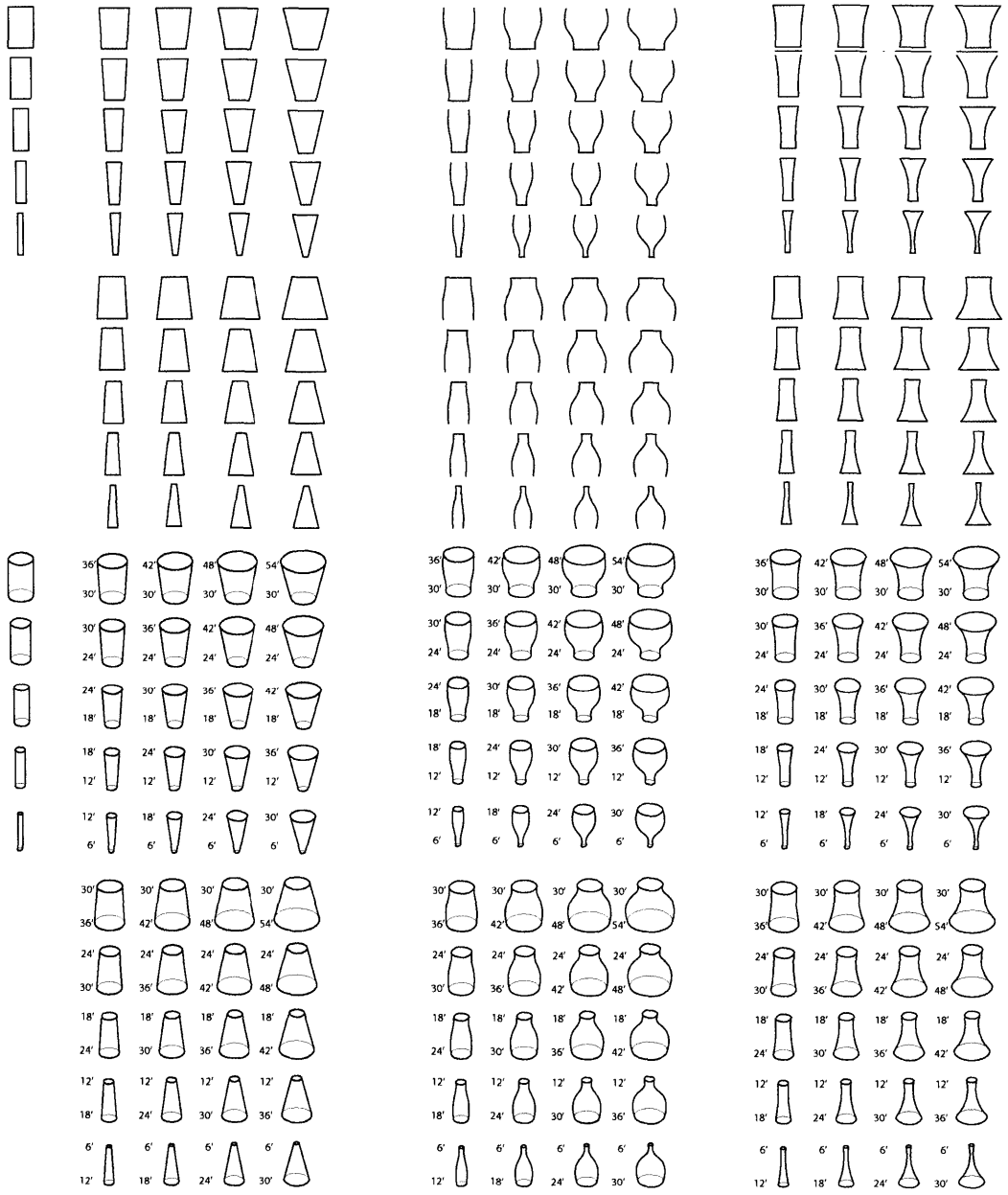


windy

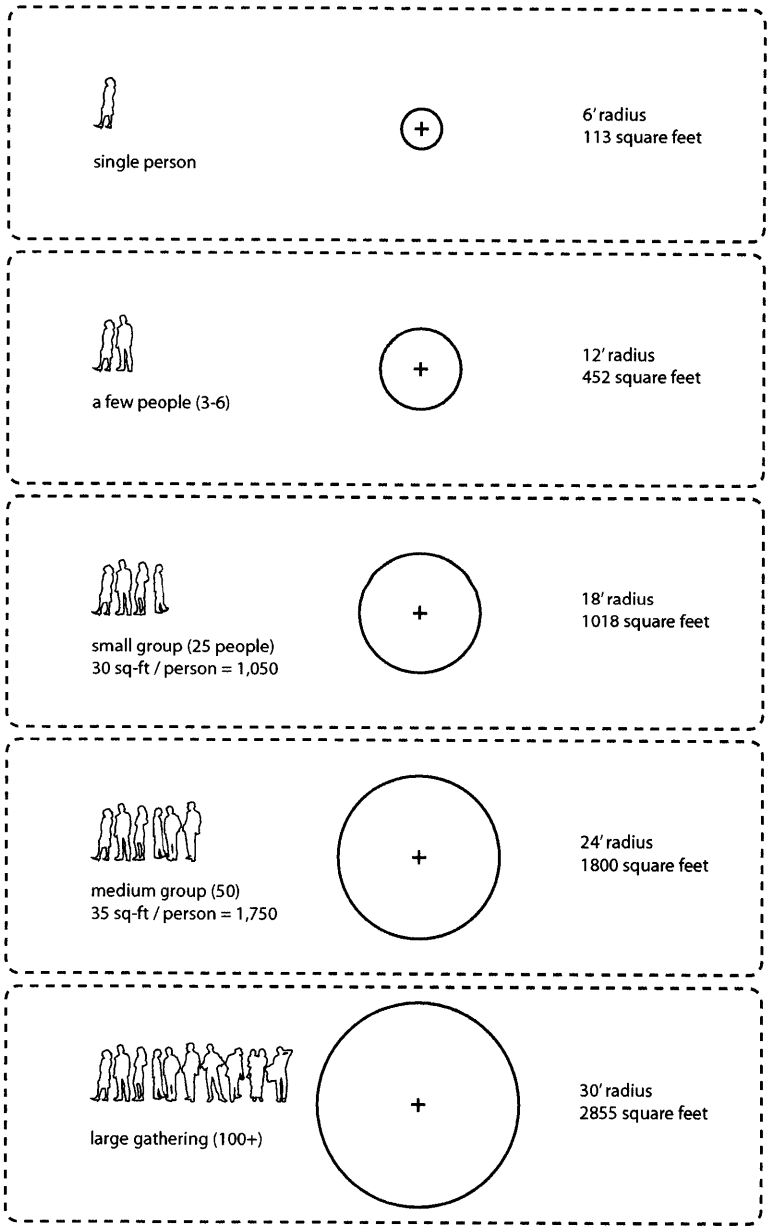


cool + wet

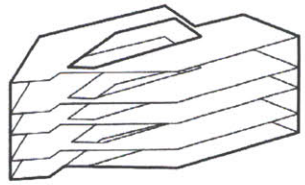
Funnel diagrams of formal options to control specific weather types



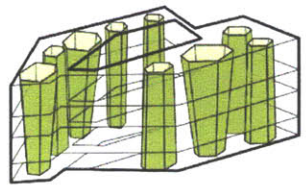
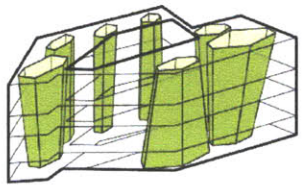
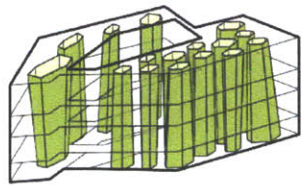
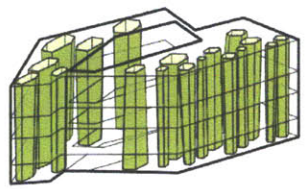
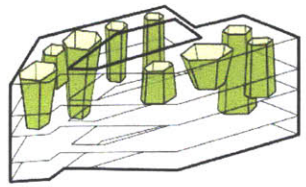
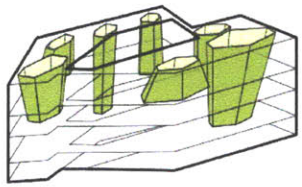
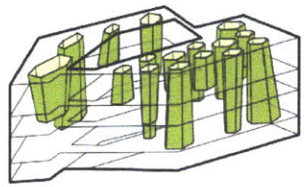
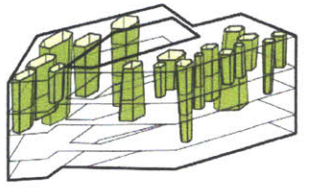
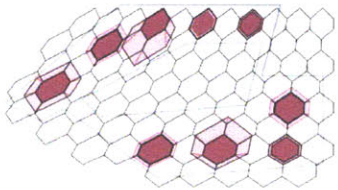
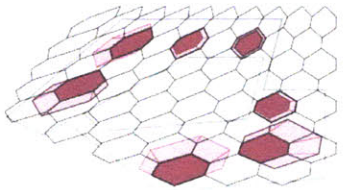
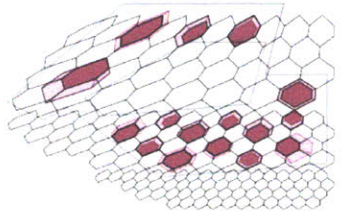
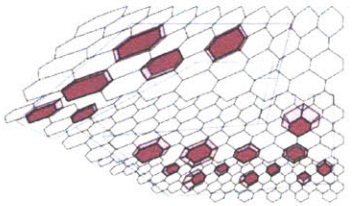
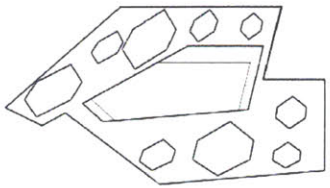
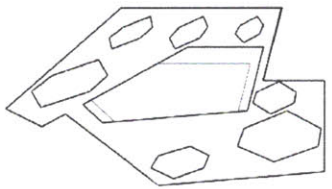
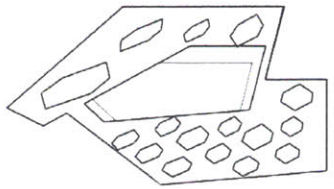
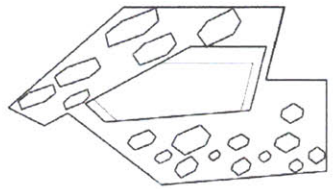
Taxonomy of size and shape: changing profile, ratio of funnel base to funnel top opening

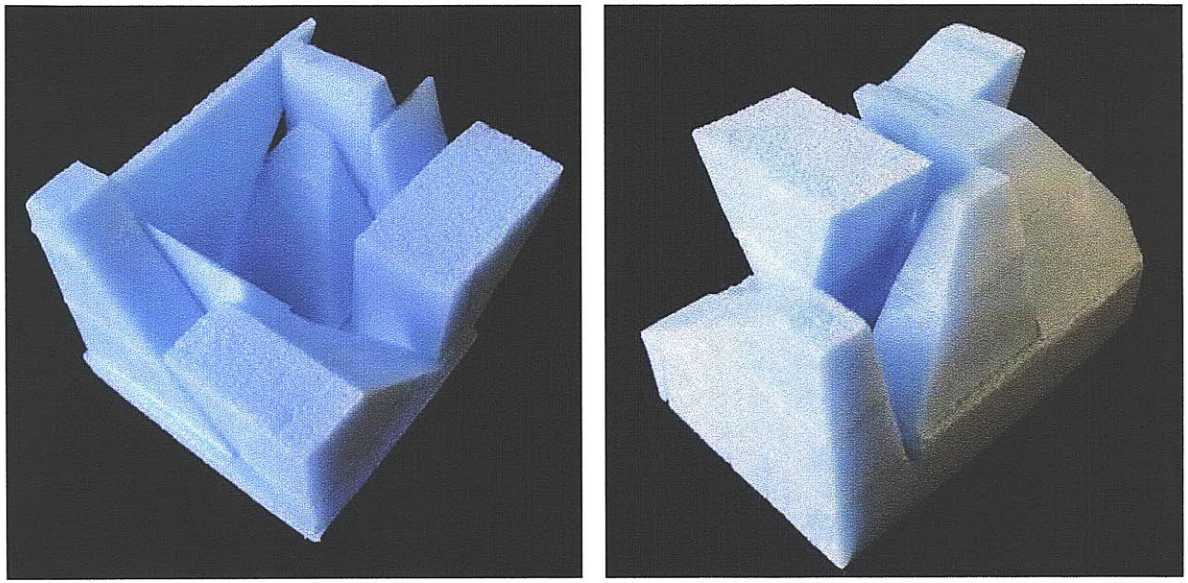


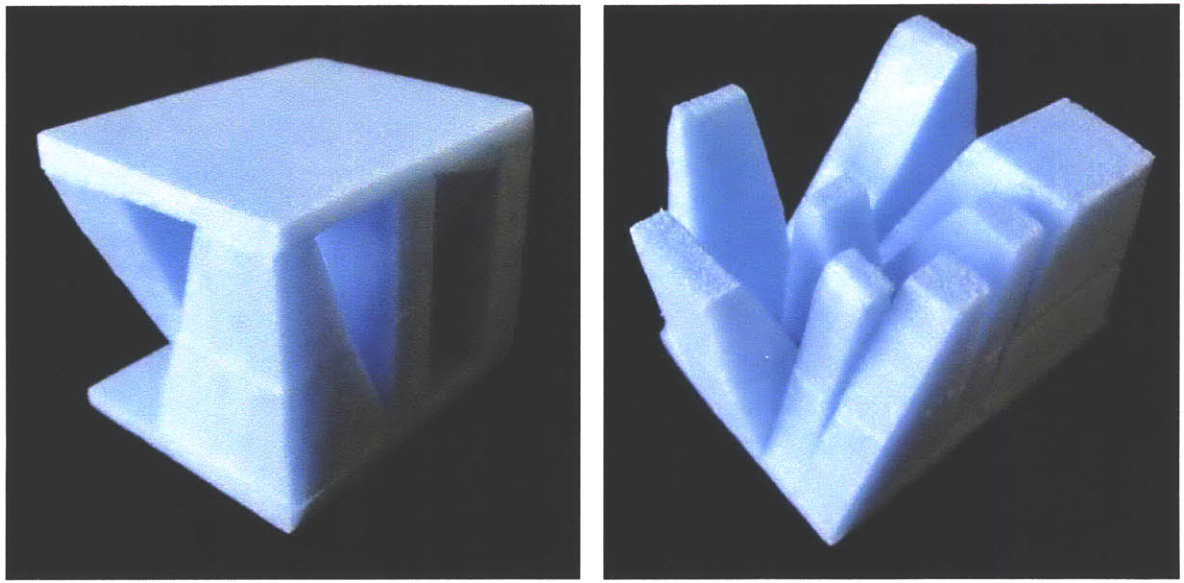
Relationship between size of the funnel and number of people it can hold



Finding the breaking point: exploration of the number of funnels the site can hold.

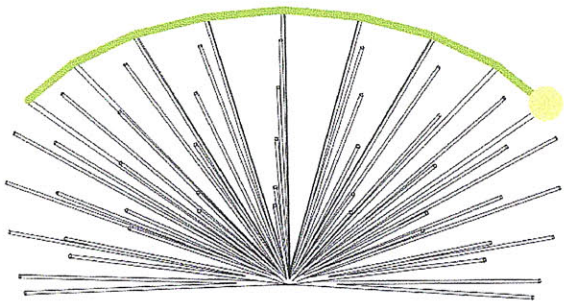


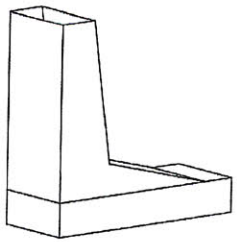


Study models exploring relationship between funnels:
do they share a thickened base? or are they capped by bookends?

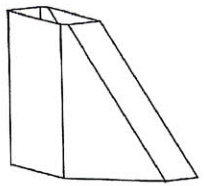
*cold

Diagrams exploring the relationship between funnel forms and sun angles

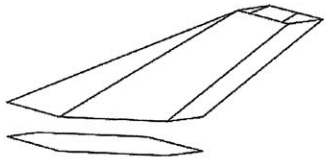




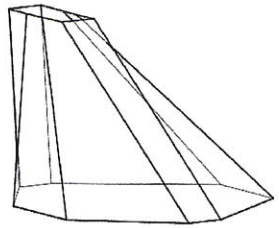
concept:
large space at base for cold pool, tapers towards top to accelerate convective air flow



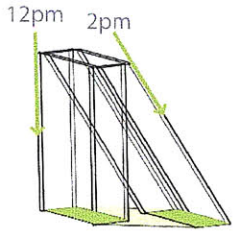
12-2pm June

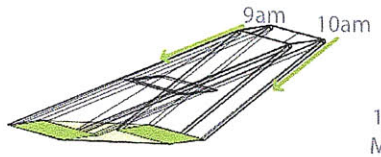


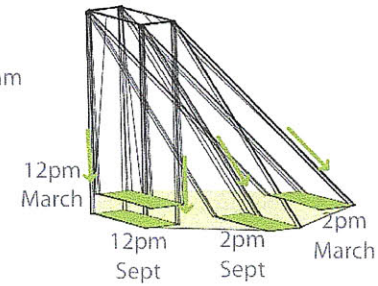
9-10am winter
(Dec, Jan, Feb)



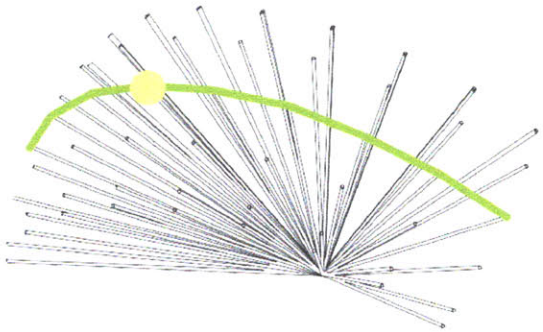
12-2pm spring + summer
(March-Sept)



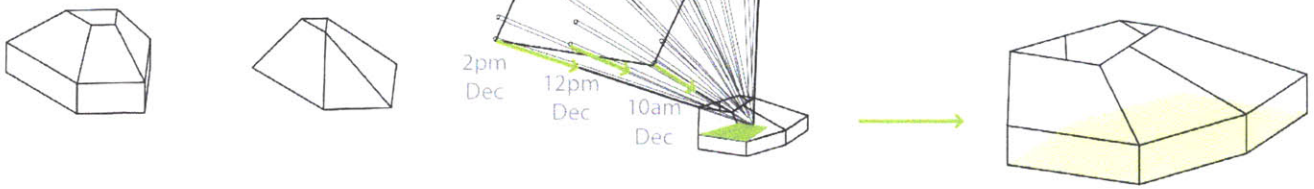




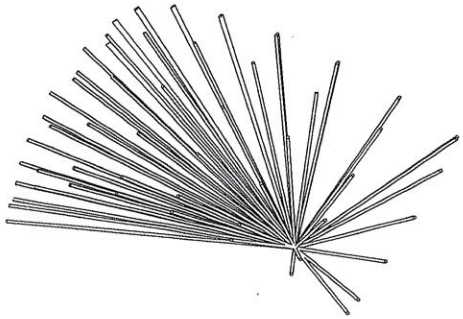
*hot

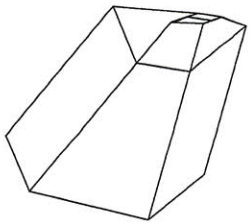


Diagrams exploring the relationship between funnel forms and sun angles

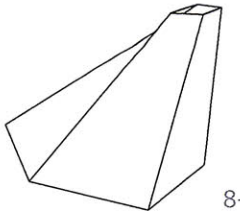


*steam

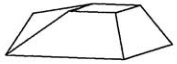




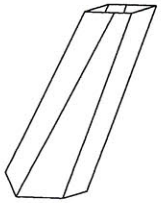
concept:
tall structure that
would allow for
the air to stratify



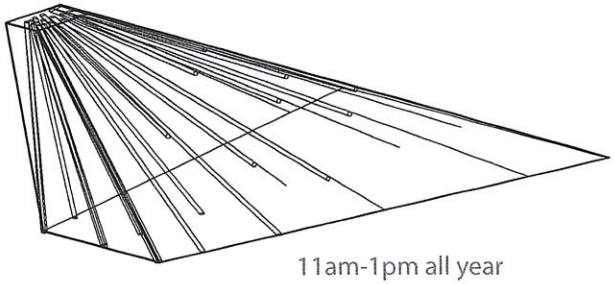
8-10am all year
(except Dec)



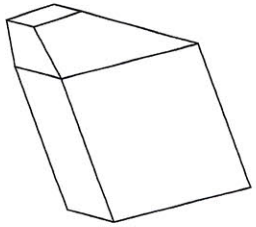
12pm spring
(May, June, July)

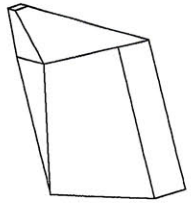


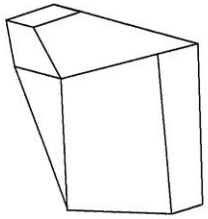
12pm June

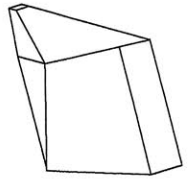


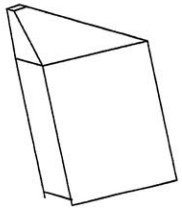
11am-1pm all year

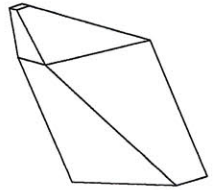






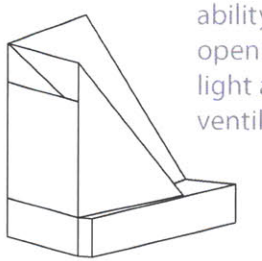


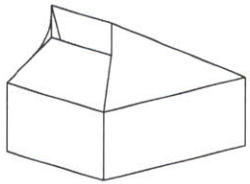




*activity

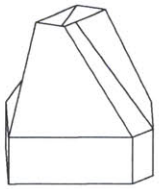
concept:
large space to hold
large group activites;
ability to open up,
opens up for natural
light and lots of
ventilation

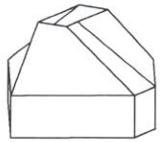




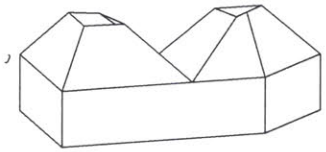
rotated to allow only
afternoon sun

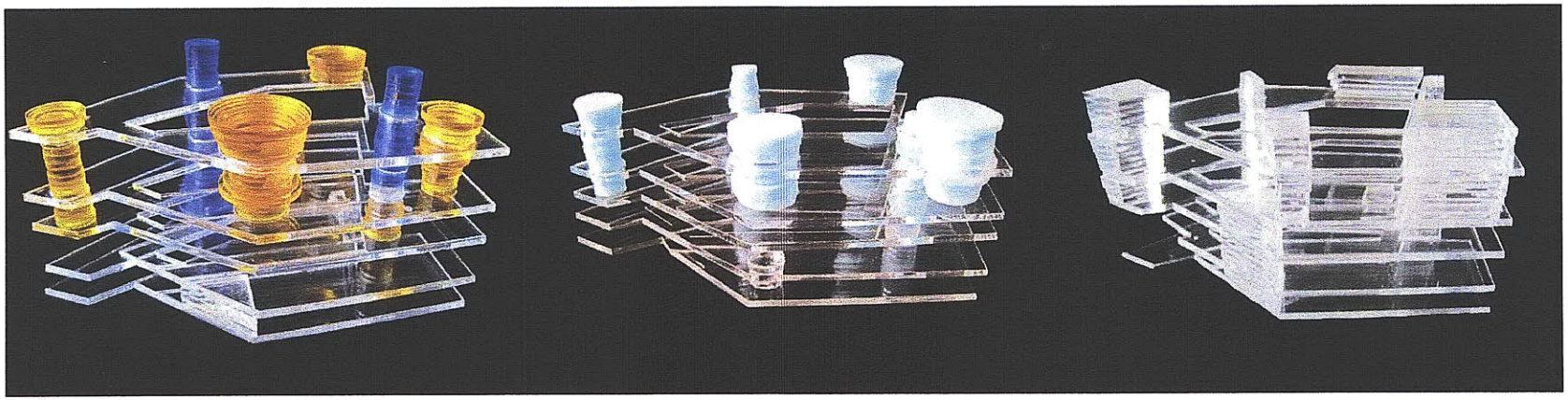
*meditation



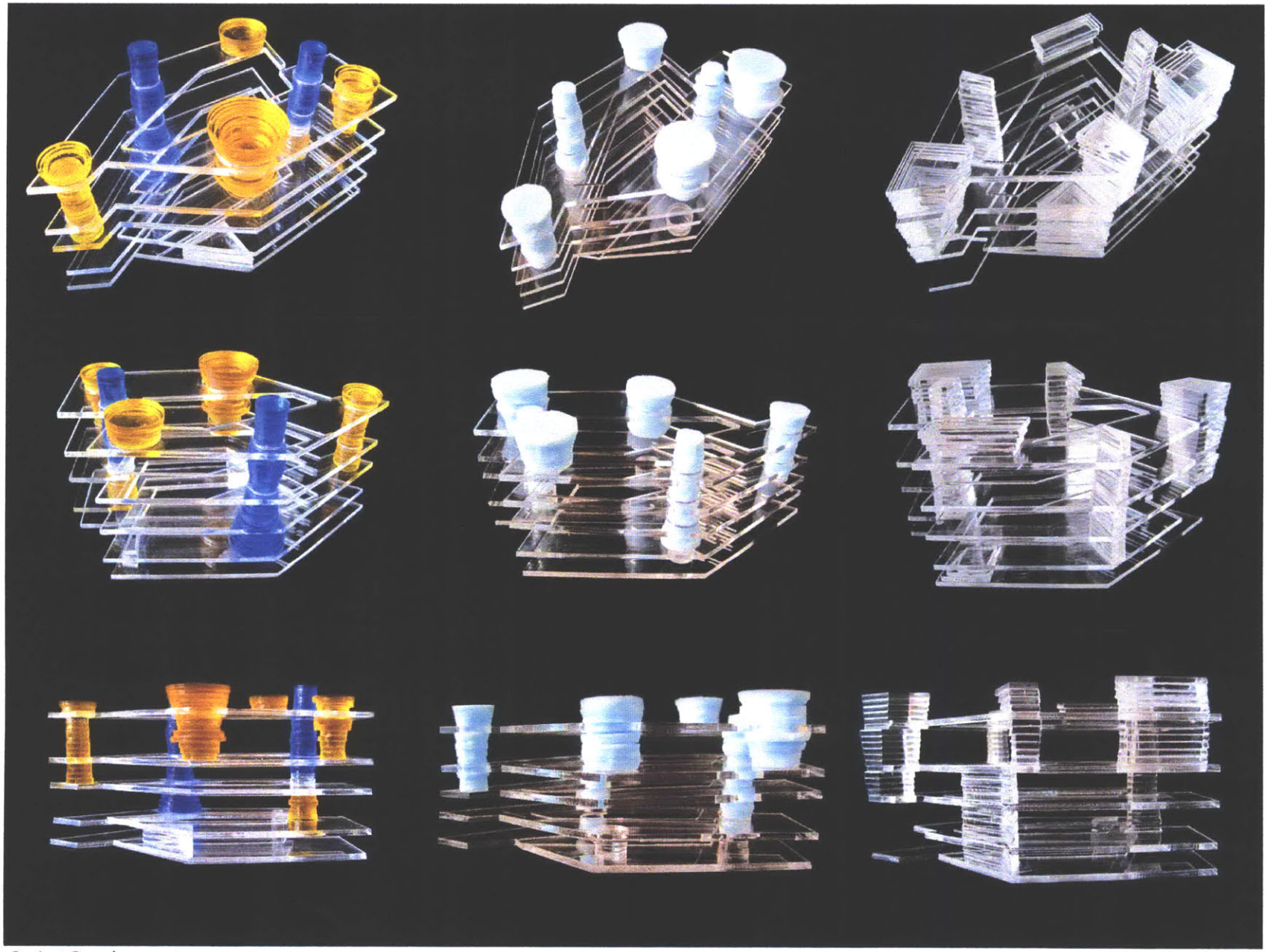


*fun



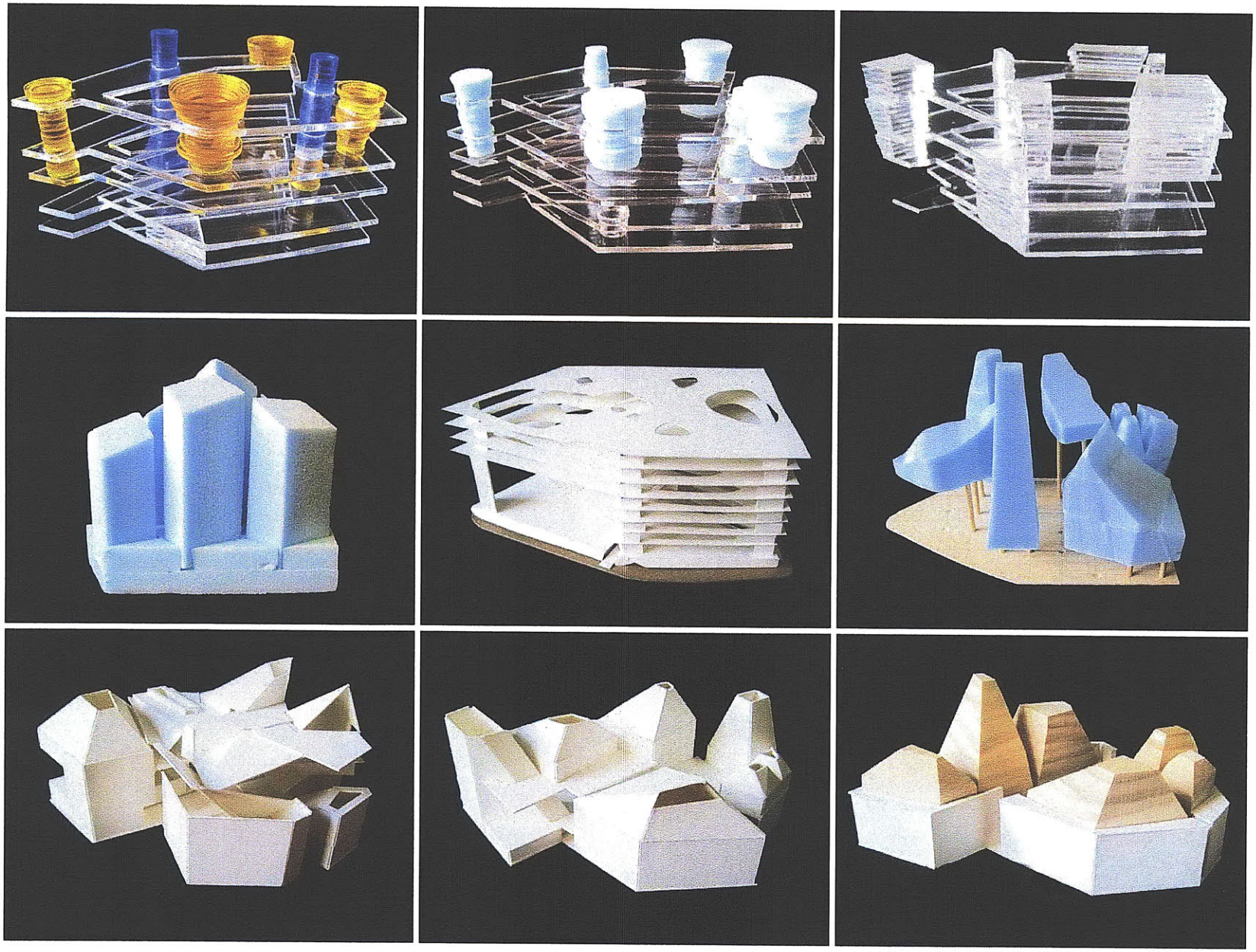


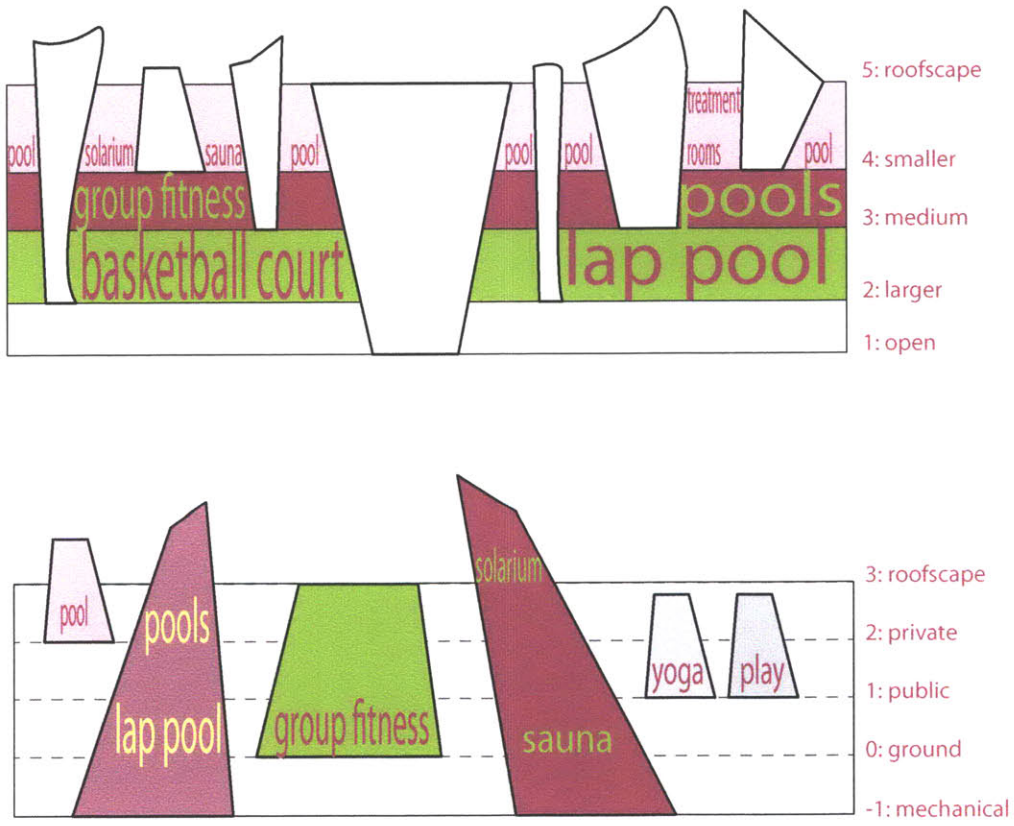
Three preliminary study models exploring the funnel forms



Scheme Development

The beginning sectional diagram of the building consisted of a mass with funnel-voids penetrating the floor-plates. The ground floor would be a large space open to the public, but as you move up into the building, more funnels begin to appear, so that by the top of the building, there are more penetrations than open space. As it develops, the floor plates disappear and the funnels become the most important elements, which float within the space.





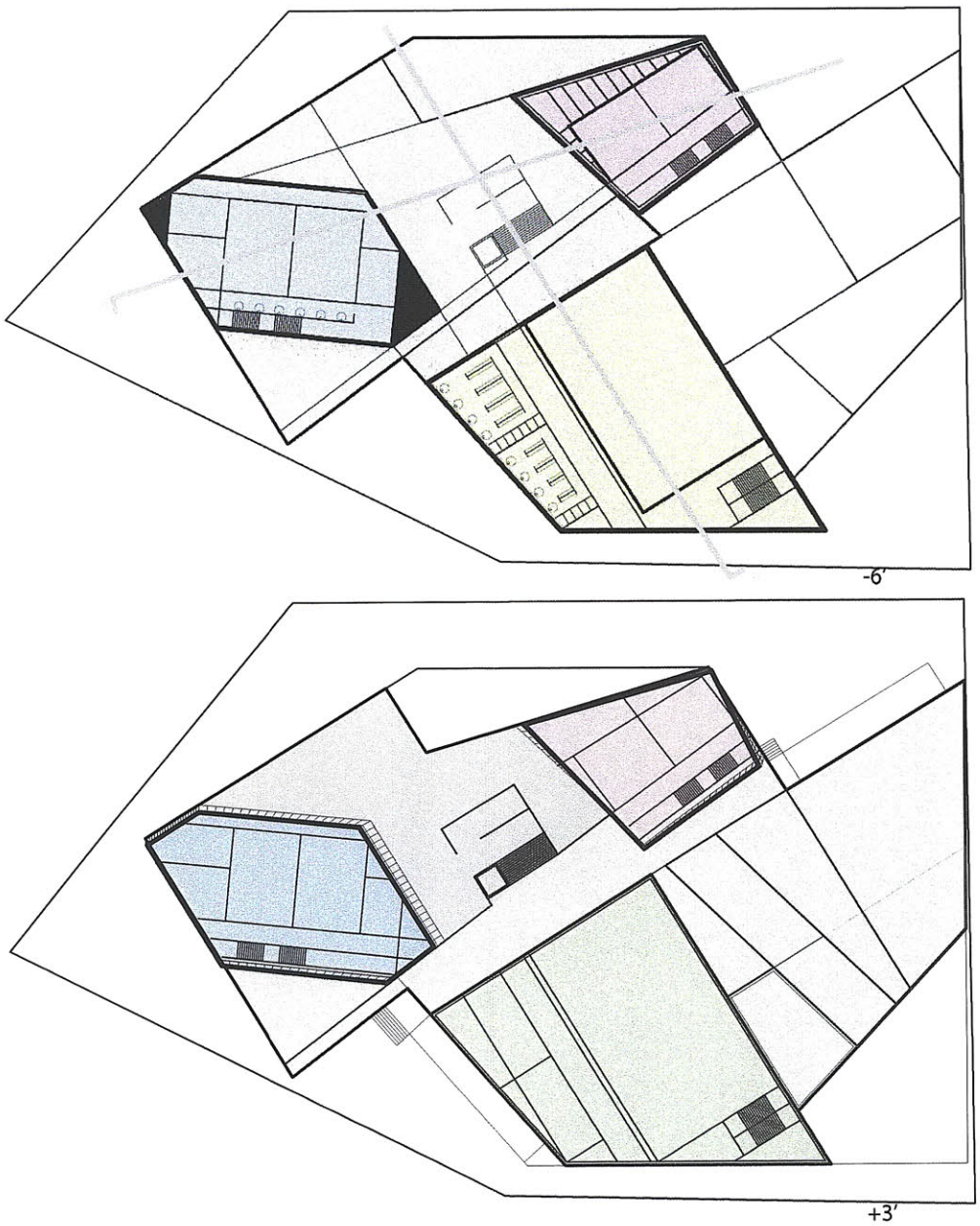
sectional diagram showing programmatic funnel clusters penetrating volume

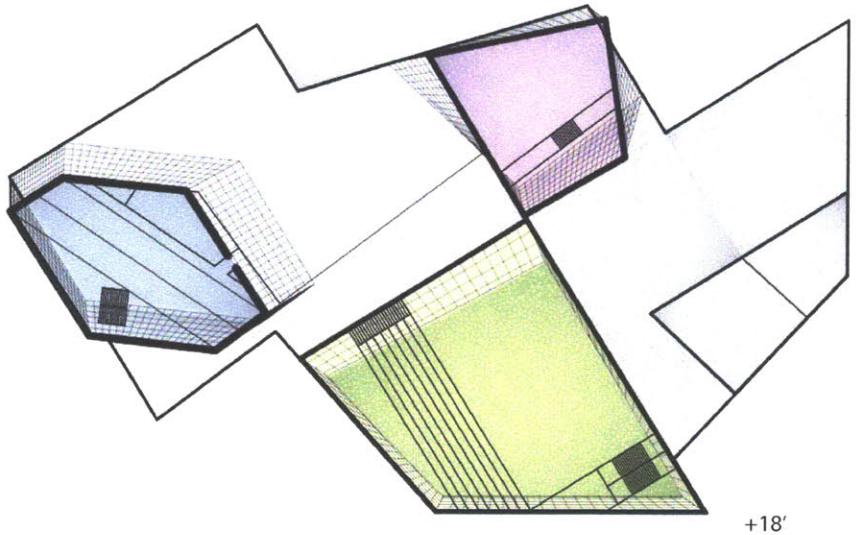
Midterm

It became clear that the building was lacking a clear parti. The shapes of the funnels seem rather random and disorganized. The sections are beginning to show some interesting spatial ideas, but they each seem to act on their own and do not speak to each other. Thickened building edges that would clearly define the building and likewise act to hold the funnels into place. It could act as an organizational device for the interior, as well as an acknowledgement to the outside, urban edge.

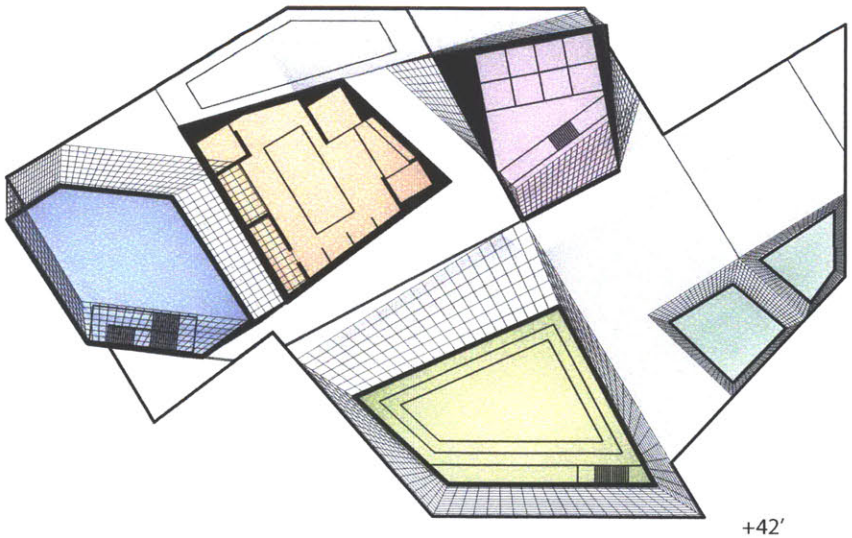
One major critique is that the interior spaces of the funnels seem too big. It was suggested that the addition of smaller sub-spaces would make it possible to control the interior environments more carefully, while also allowing the exterior funnels to become thinner, and possibly even transparent. This would still allow for the large funnel to remain a visual icon, while the smaller interior clusters could have greater environmental extremes.


32′
64′
128′


-6'
+3'

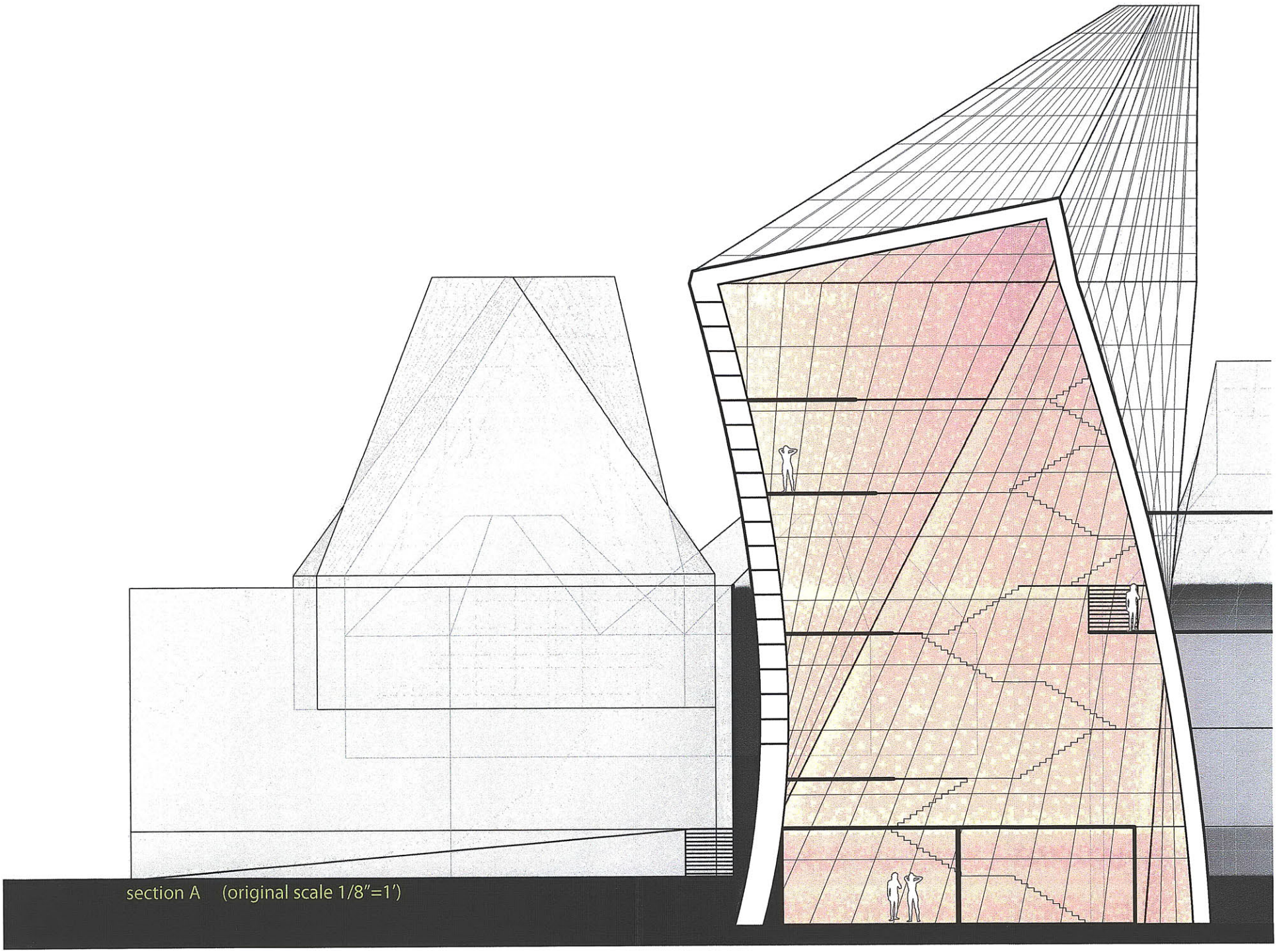


+18′

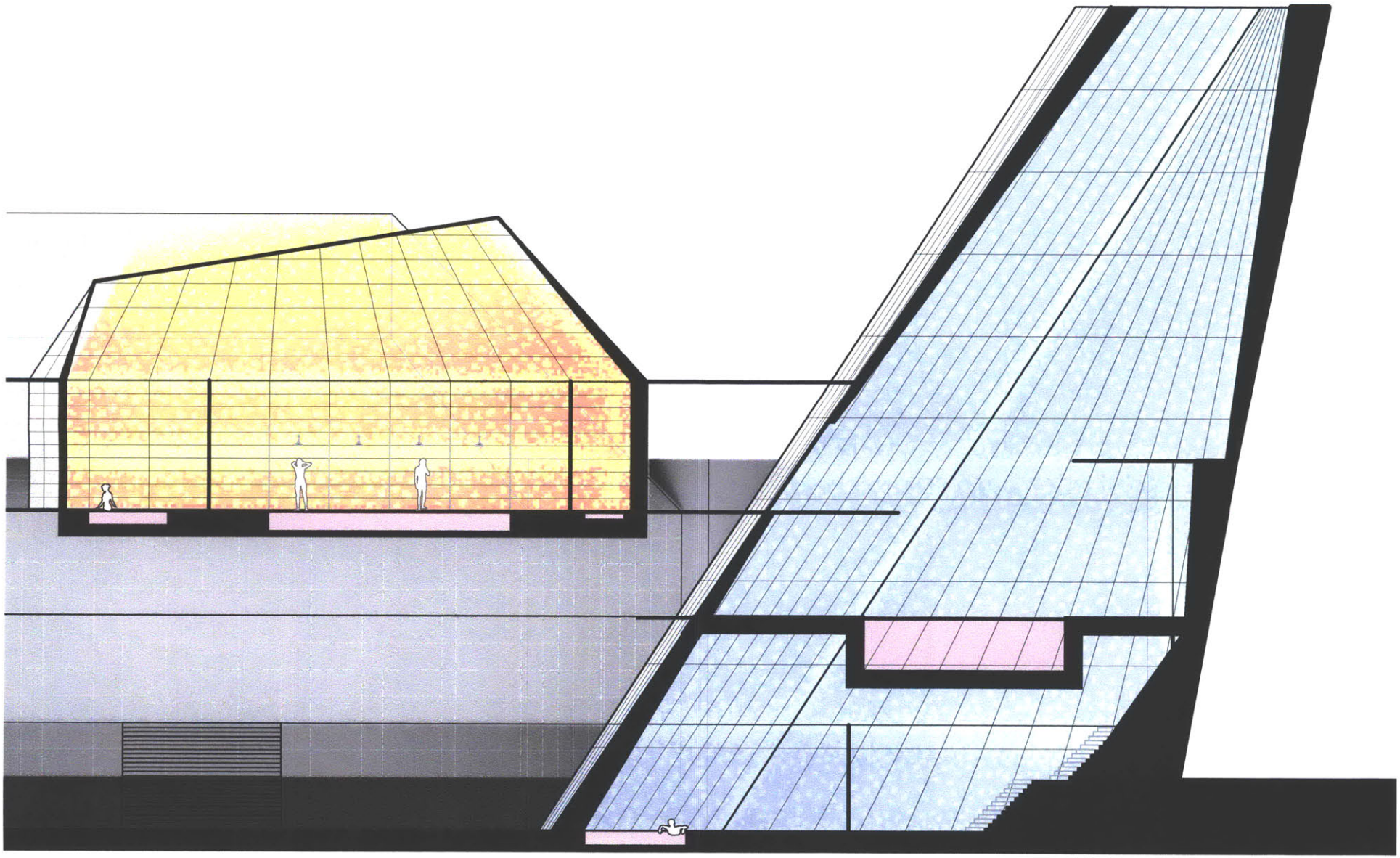


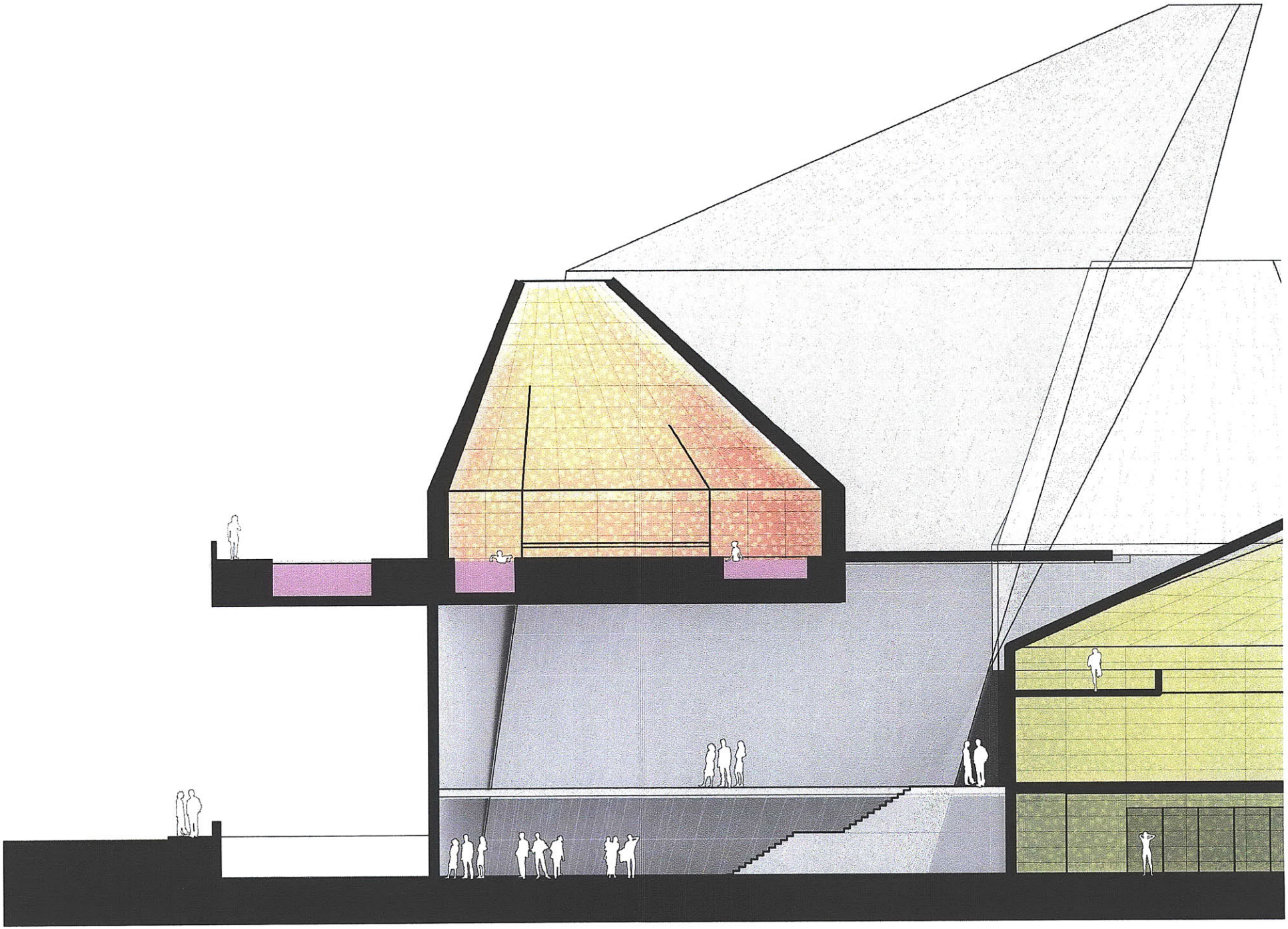
+42′

floor plan diagrams



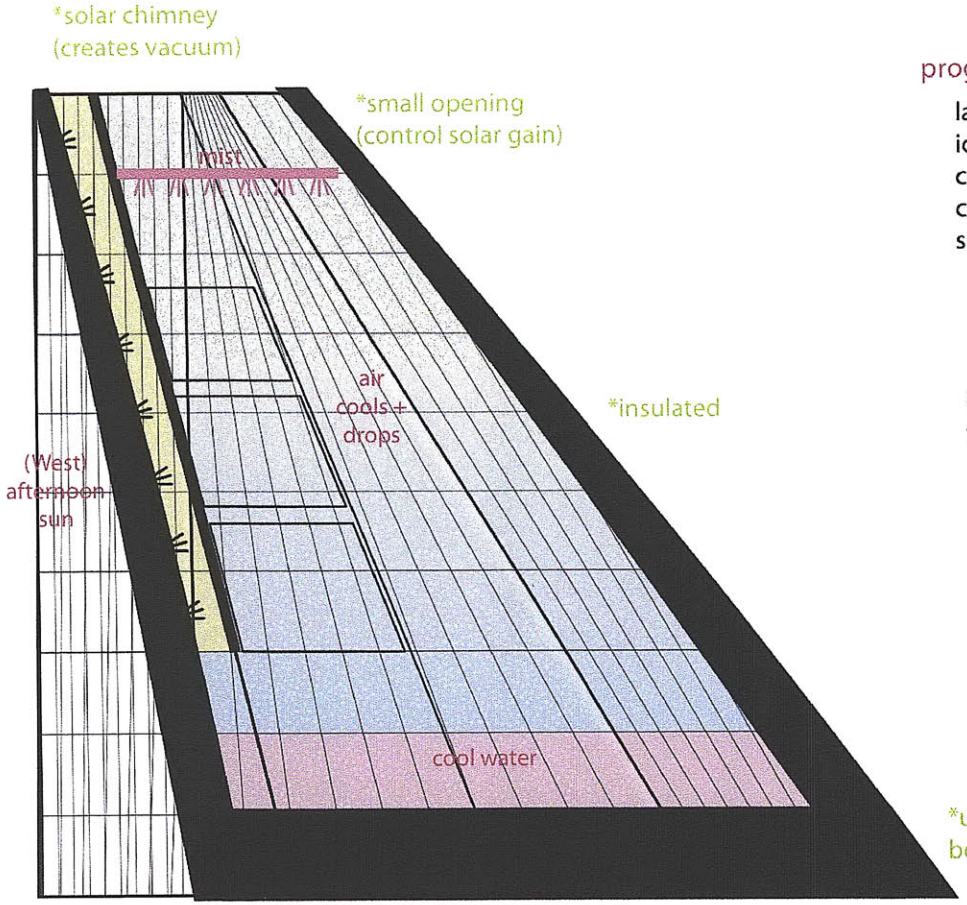
section A (original scale 1/8″=1′)





section B (original scale1/8″=1′)

*cold

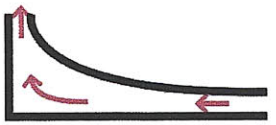


program: cold to cool pools (5000 SF)

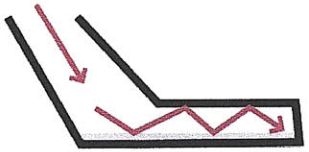
lap pool (lane 9' x 90', 4x lanes 3240 SF) - *78-82° F
ice dunking pool (200 SF) - *50-59° F
cool soaking pool (1000 SF) - *70-78° F
cool showers / cool-down room (400 SF)
snow room (200 SF) - * air temp 35° F

= steam

warm pool in cool air



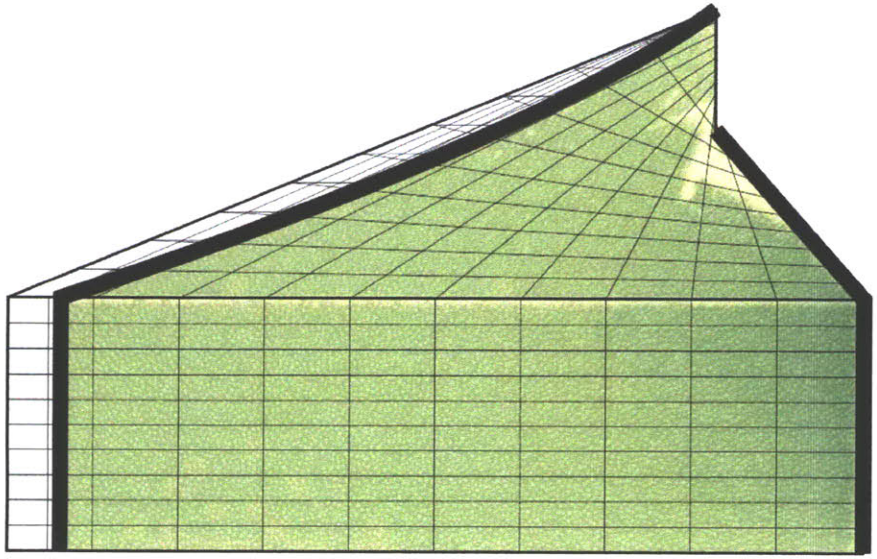
* ventilation to cool_
air cools as it moves across water



* sun moves deep into space by reflecting off water

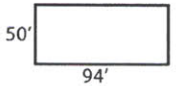
*use length at bottom for lap pool

*ventilated + sunny: group activity

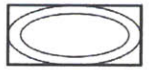


program: Fitness_ group activity space

basketball court: 4700 SF



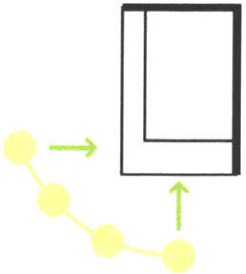
track: 4000SF



fitness equipment rooms: 2000 SF

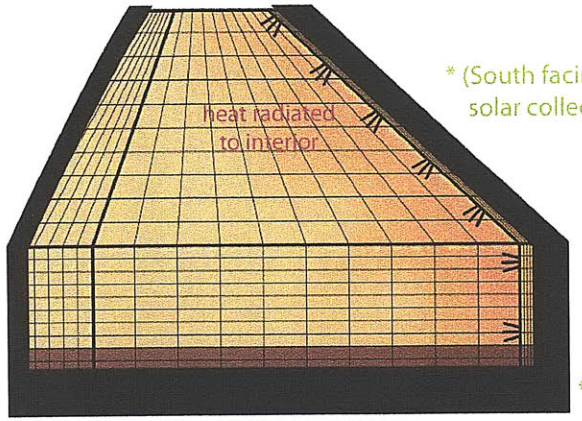
*air flow is important aspect of form

average velocity is 10-13 mph; prevailing winds from the West



ability to open up to outside / ventilate / allow for sunlight

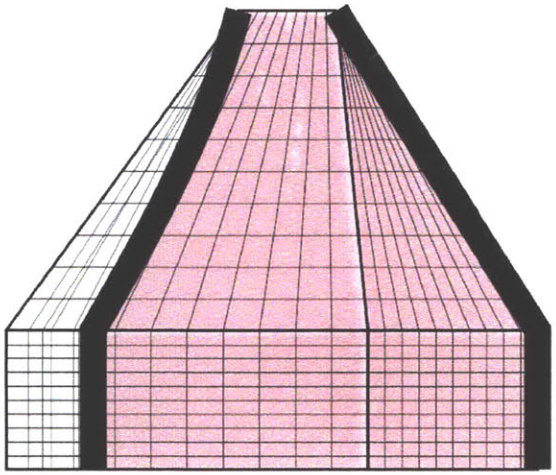
*hot



program: hot to warm pools (5000 SF)

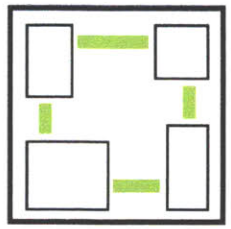
hot dunking / immersion pool (200 SF) - *104-113° F
hot bath for extended soaking (400 SF) - *max 104° F (range: 98-104° F)
warm exercise pool for arthritis (1000 SF) - *83-88° F
warm pool for soaking + chatting (no activity) (1000 SF) - *88-90° F
warm leisure areas , dry (200 SF x 5 = 1000 SF) - * air temp 80-85° F

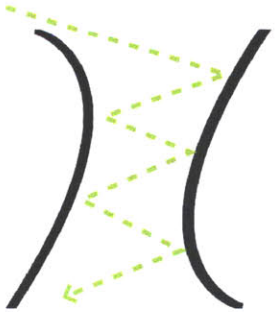
*meditation + treatment



program: meditation + treatment facilities
individual rooms: chiropractic / acupuncture / massage therapy
individual - group rooms: meditation / yoga / pilates

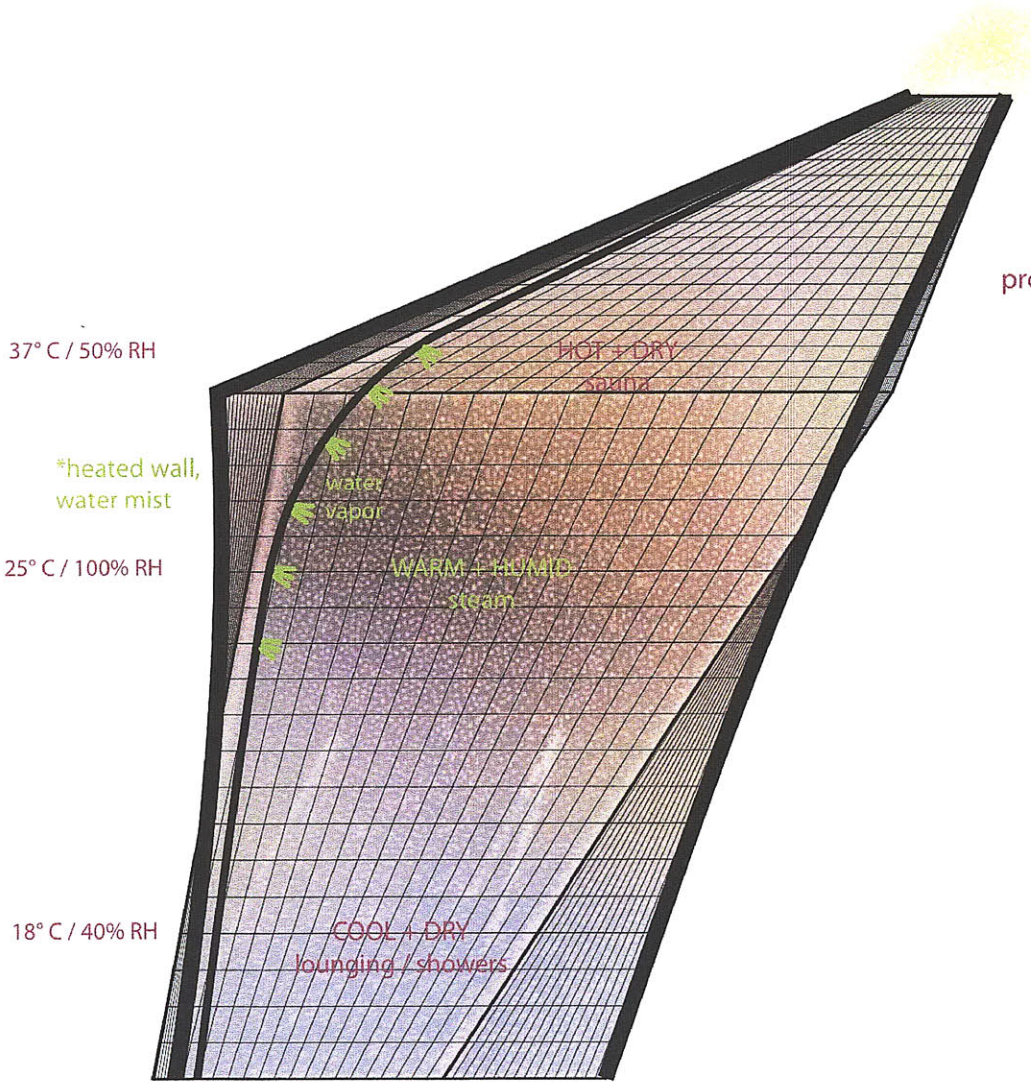
single rooms: 8' x 10' = 80 SF
double rooms: 10' x 10' = 100 SF
small group: (each 8' x 8' x 3) = 200 SF
medium group: (each 8' x 8' x 8) = 500 SF





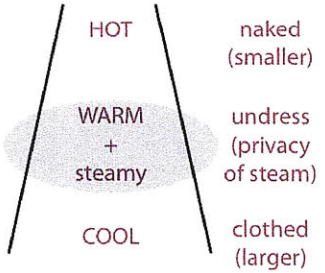
soft_ reflected light
quiet_ insulated

*humid



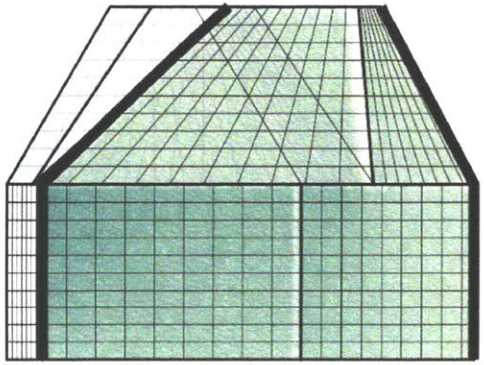
program: sauna, steam, solarium

area for disrobing - warm
wet / steam - 40° C (104° F) 100 RH
dry / sauna - 60°-100° C (140°-212° F) low RH
solarium - warm, sunny

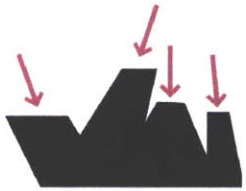


air-to-air heat pump, extracting heat from space below cloud and supplying it to area above the cloud, both by low flow air return systems without mixing the thermal layers (humidification system within the cloud) (from Cloudscapes by Transsolar)

*children's area



program: daycare, pools, play area
(=3000 SF)



multiple colors...
different time of day/year, sun illuminates different funnels
illuminates programmed areas, creates a schedule or clock

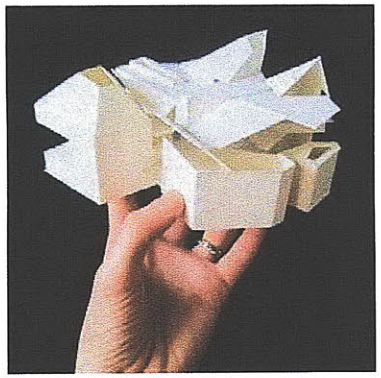
Hygeia* weatherized

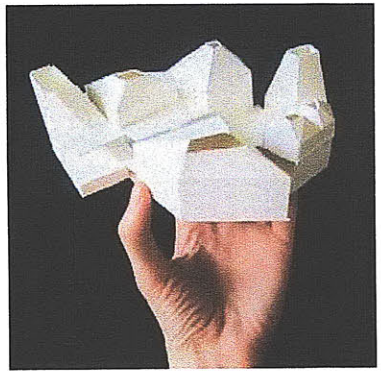
The Final Project

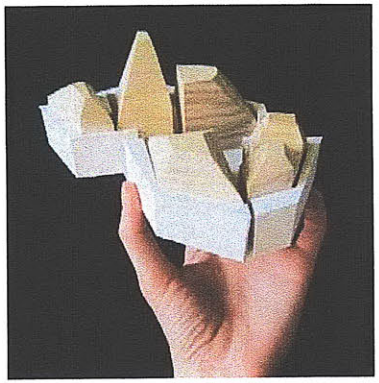
FINAL DESIGN

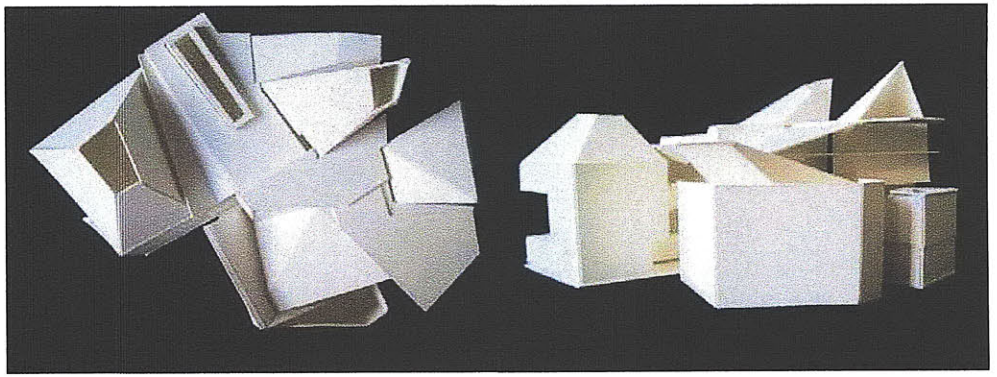
The project is a landscape of funnels that contain different interior environments. Public space is brought into the building and allows for the mixing of Harvard and the Allston residents. The relationship between interior and exterior, and public and private is played with in the building so that unique moments between the two are encountered. The three most important elements in the design will be discussed in greater detail: the parti of the building which encompass the relationships between public/private and interior/exterior; the exterior wall; and the funnels.

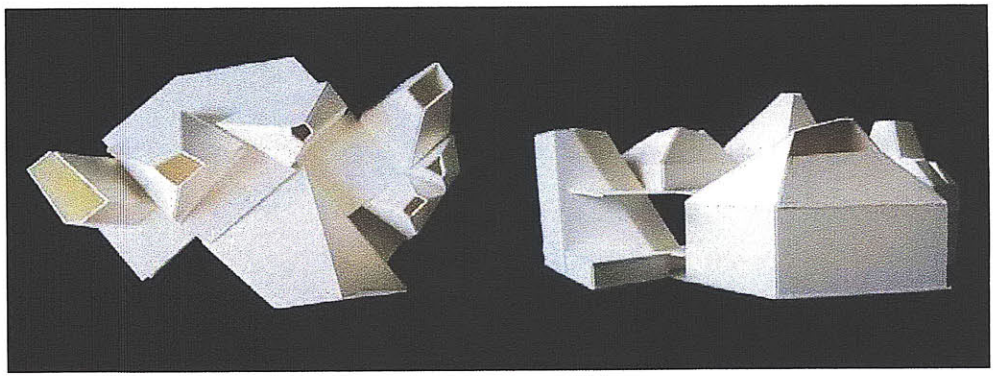

32′
64′
128′

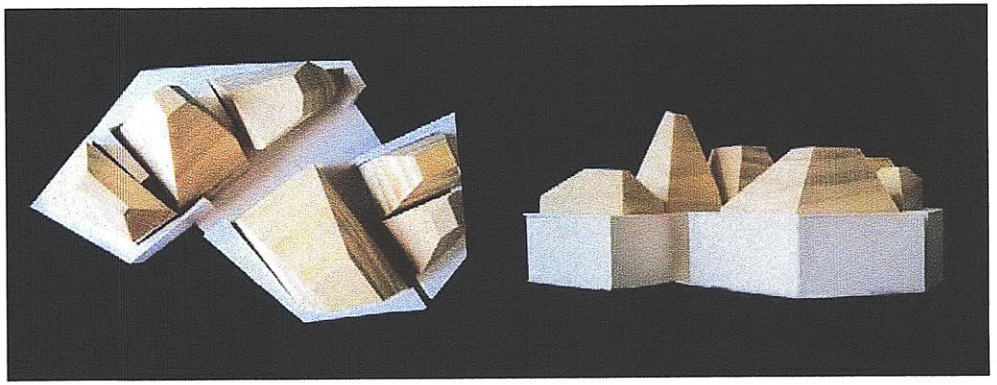


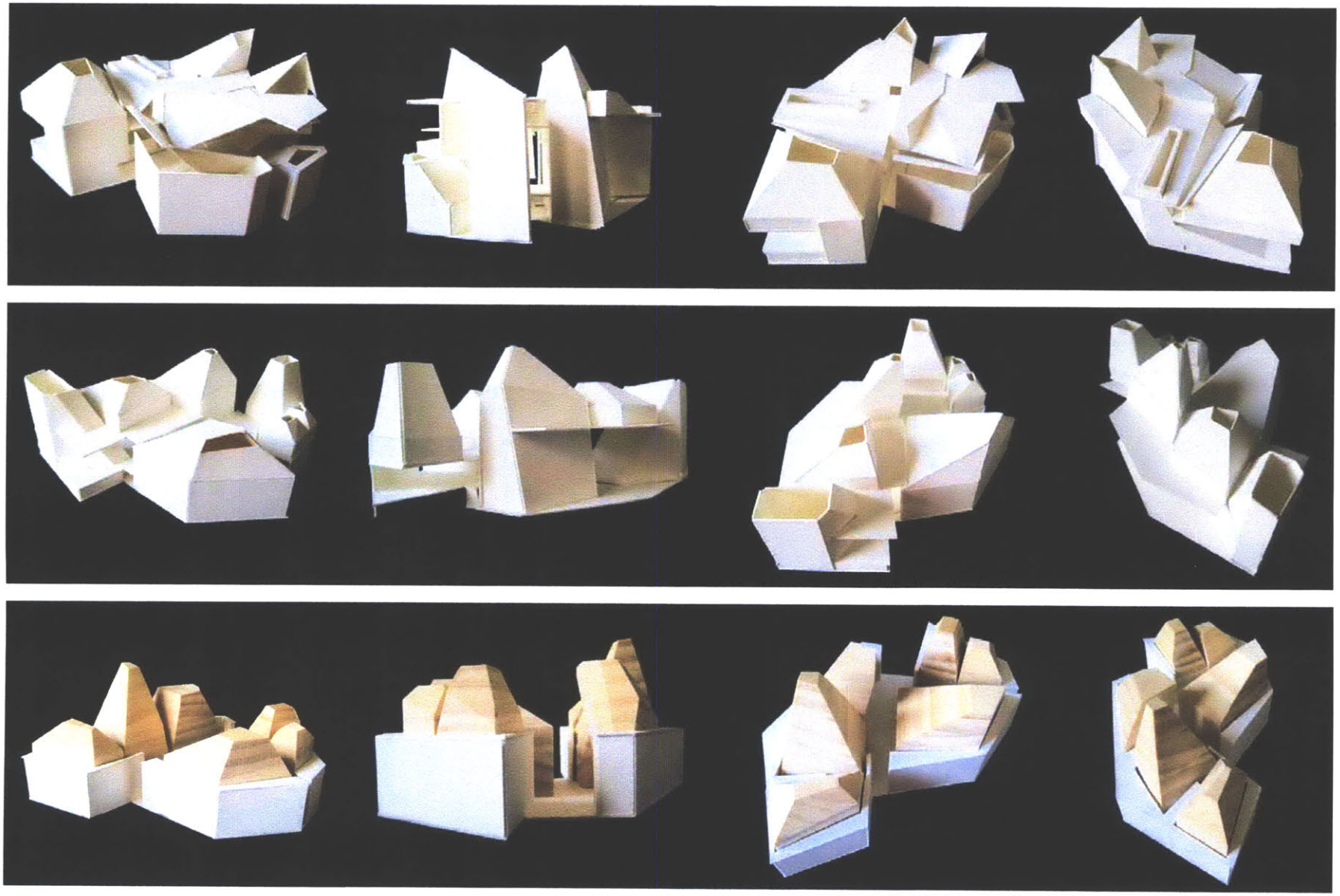


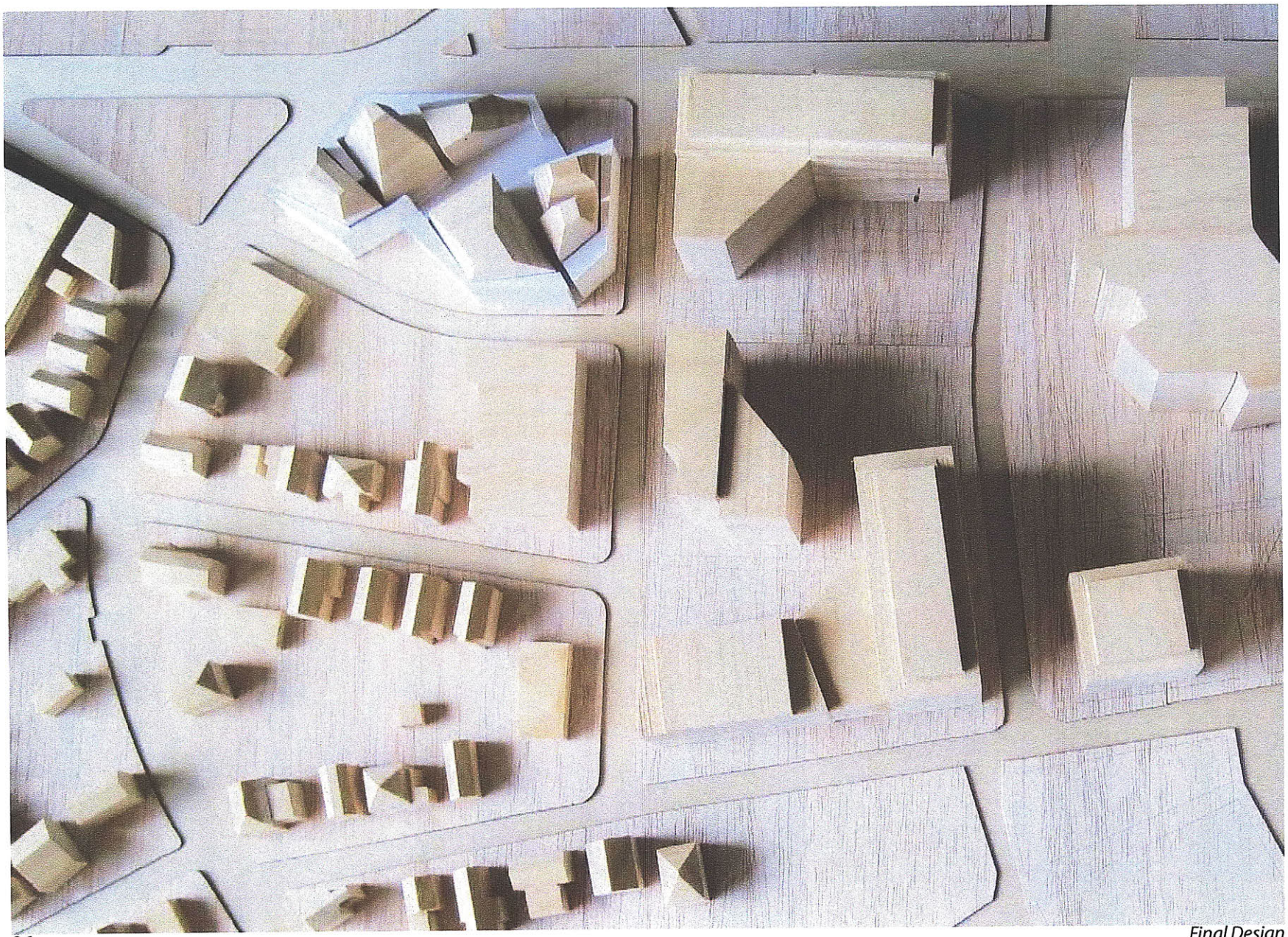




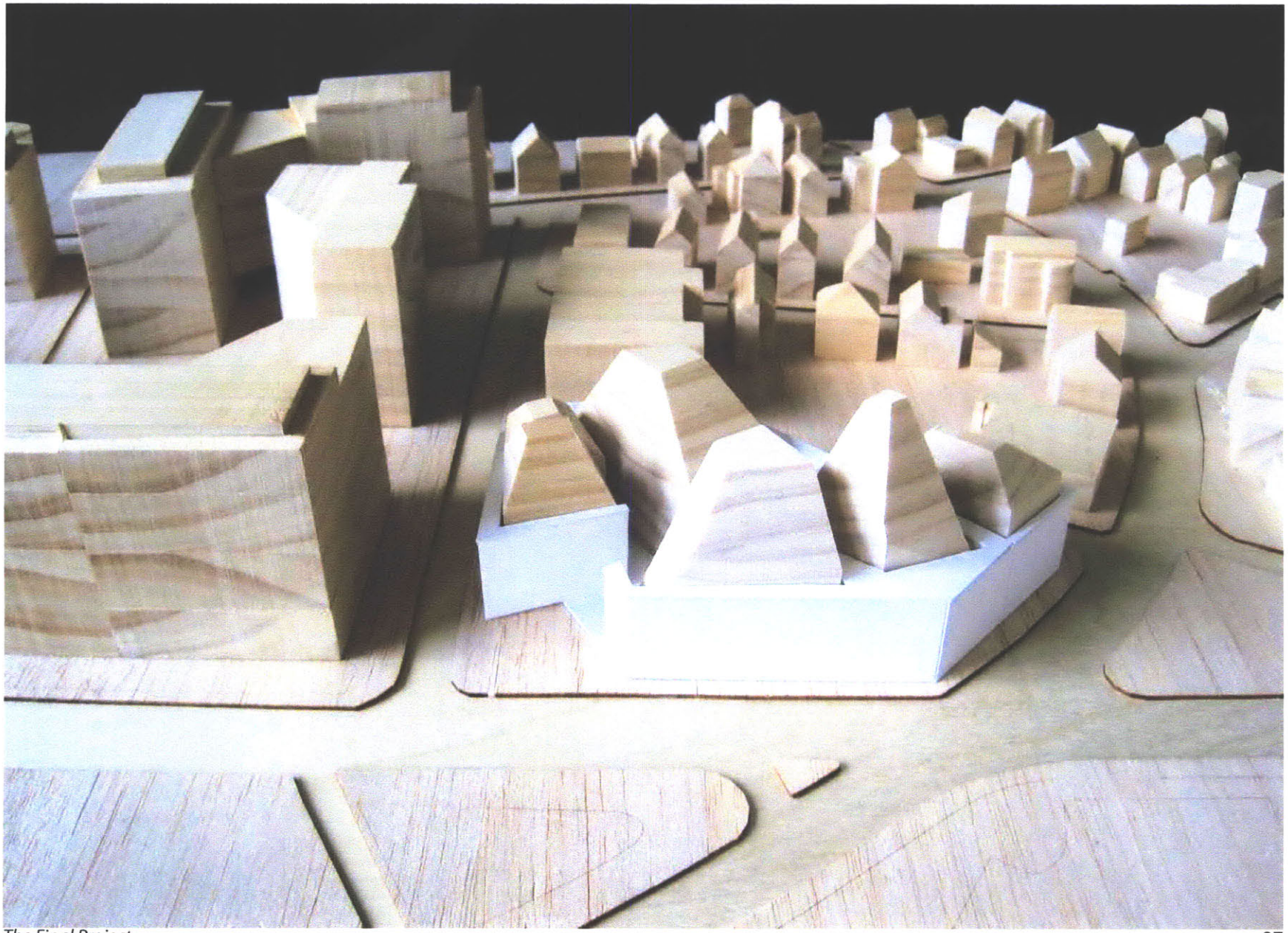


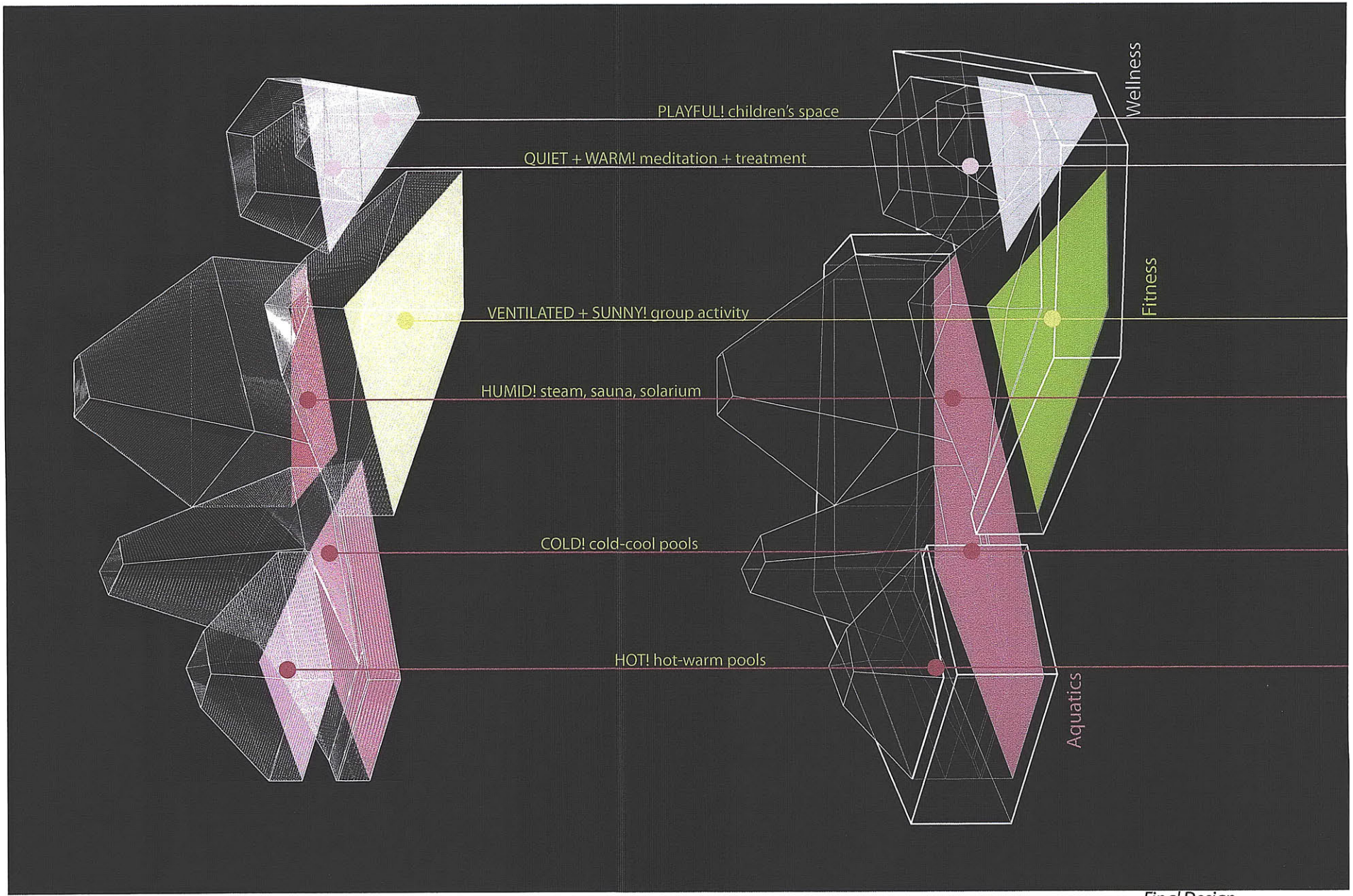


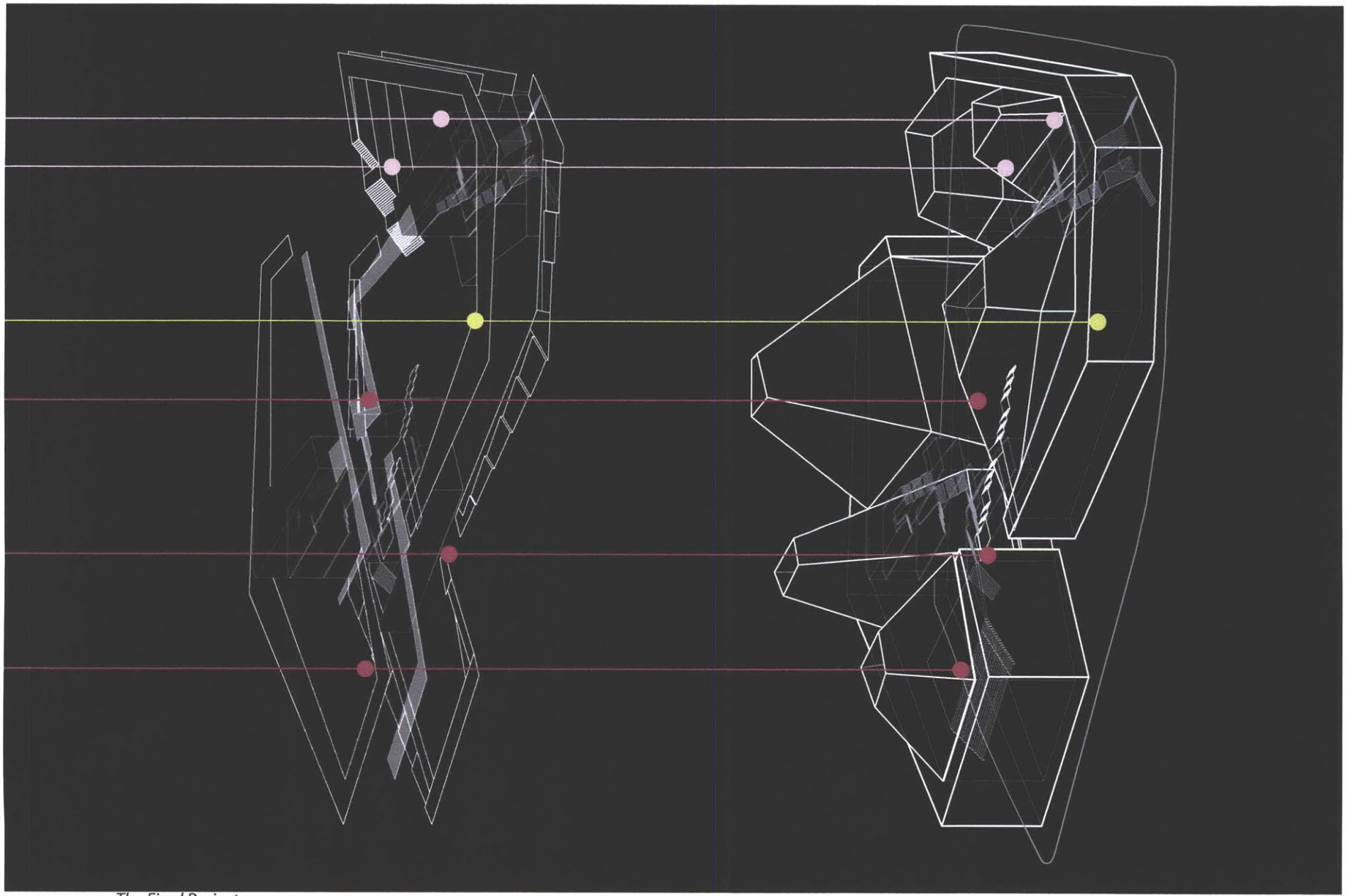


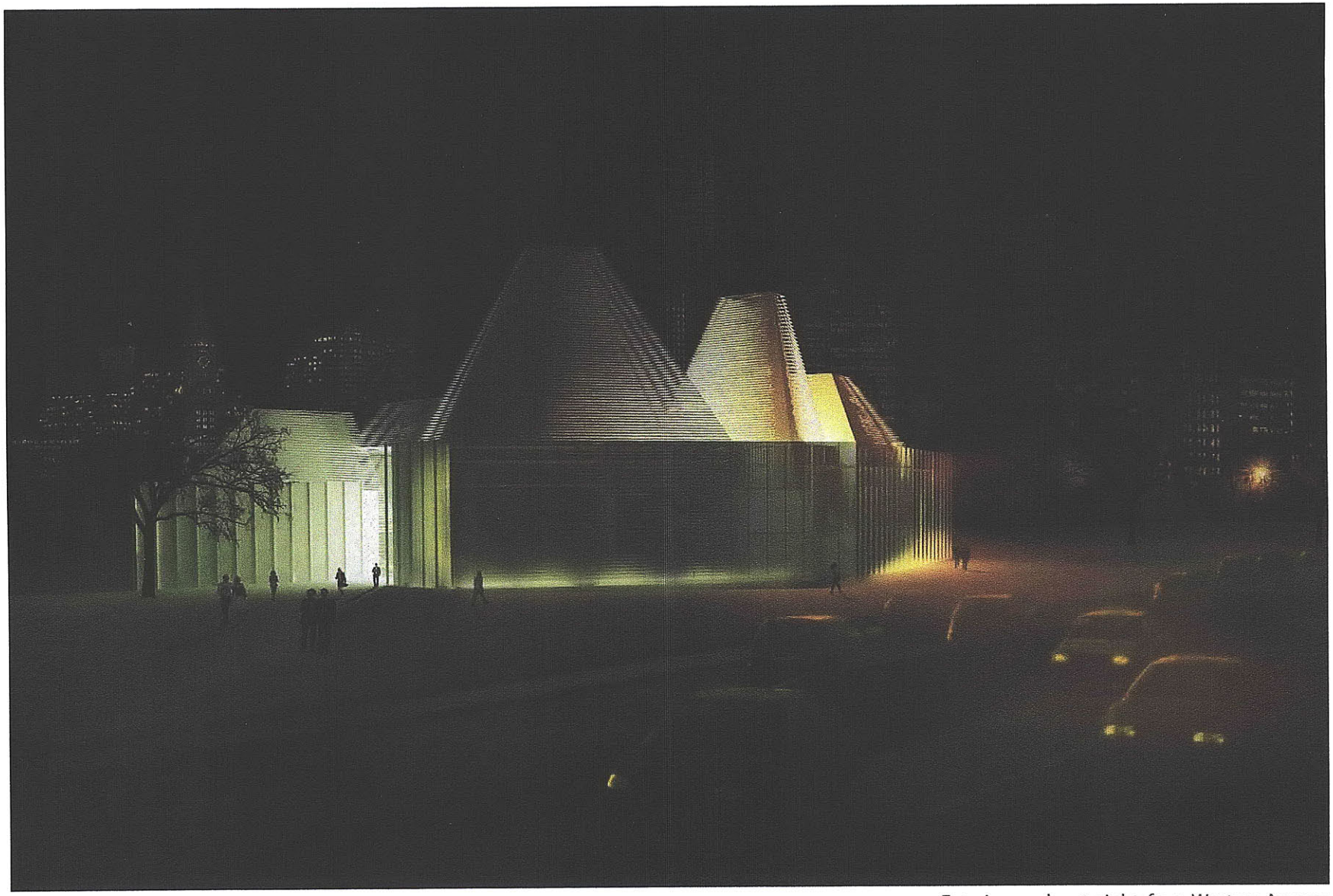


Final Design




PLAYFUL! children's space
QUIET + WARM! meditation + treatment
VENTILATED + SUNNY! group activity
HUMID! steam, sauna, solarium
COLD! cold-cool pools
HOT! hot-warm pools
Wellness
Fitness
Aquatics





Exterior render at night, from Western Avenue

FINAL DESIGN

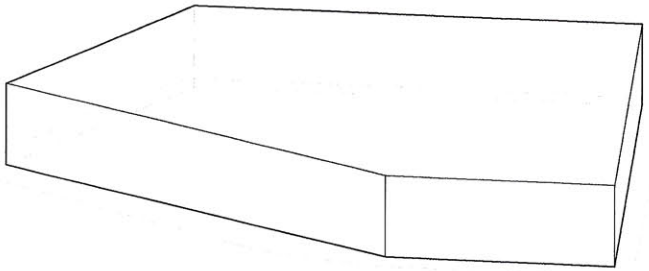
Organization / Parti

From the very beginning of the design process, the massing, flows, and public space were very important. The building fills the site, but is carved away in two places to create a public gathering space and entry point: one on the residential edge, and one on the major public edge. On the ground floor between these two entries the major circulation artery that runs through the building. It acts as a public collection space and mediator between the two major forces of the site (Harvard's campus and the Allston community). This artery is not only a public connector in plan, but it also cuts through the building sectionally, allowing for a coherent visual understanding of the building. The vertical circulation for the public directly extends from this space, up into the atrium/ cavern. The private circulation is enclosed and wedged between the funnels. The enclosure allows visitors to move between the dressing rooms and the fitness, wellness, and aquatic zones in privacy.

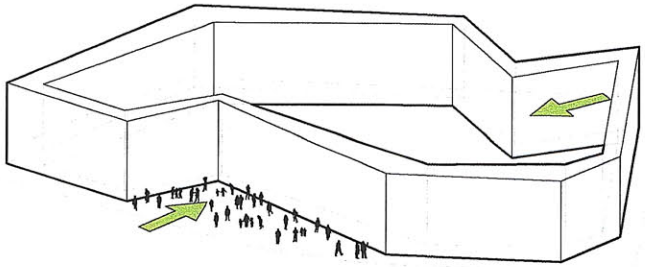
In regards to publicness, the building is in a way flipped inside-out. The most public space of the building is in the middle, and makes up the 'heart' of the building. To access the private, 'undressed' spaces, the user must enter the exterior wall, which envelops the building. This wall is the outer-most part of the building, and is, in a way, in the most public location of the site.

There is not a clear division between 'in' and 'out' in the building; instead there are degrees of 'interiorness' and 'exteriorness.' The wall marks the building edge, and is the beginning of the interior of the building, but has the ability to be opened up, therefore become the exterior of the building edge. The main interior space is obviously inside, but is 'exterior' in relation to the funnels. The building can be opened up to breathe and react to temporal and seasonal changes. This lends itself to a building where the degrees of 'interiority' and 'exteriority' are blurred.

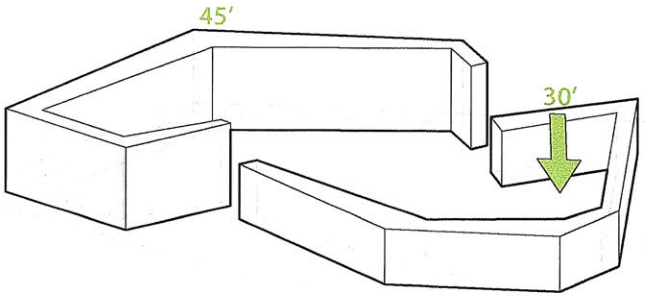
Programmatic adjacencies were mapped based on proposed users' needs. For instance, someone using the fitness area may not have the desire to be a part of the entire aquatics center, but they may want to use the lap pool as part of their workout, or the sauna to relax after their workout. These types of specialized uses are accounted for in the connective tissue of the building. Although the areas are divided between the fitness, wellness, and aquatics, there are a series of bridges, the "connective tissue", that tie these pieces back together.



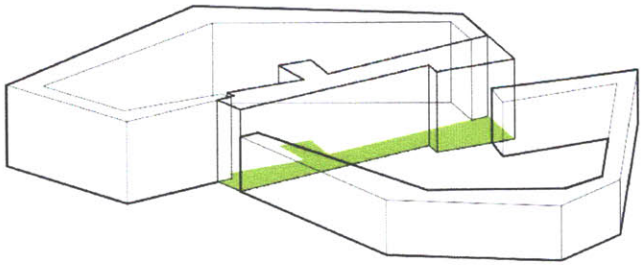
Fill site



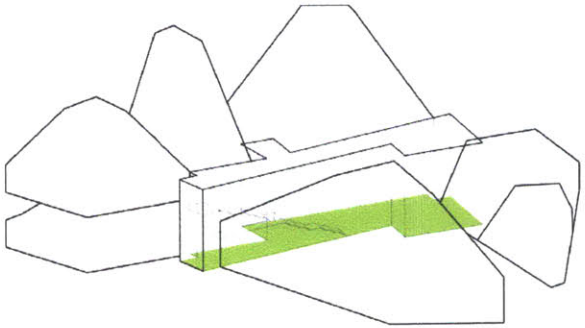
push in edges to
create entries



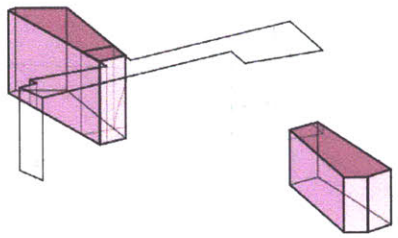
push down back
wall to lower
towards residential
scale



major circulation artery cuts through building to connect two corners of site/ entries



public, vertical circulation extends off central artery



wedges_ private circulation spurs off central space and is wedged between funnels.

Render of wall space "in-between" interior and exterior

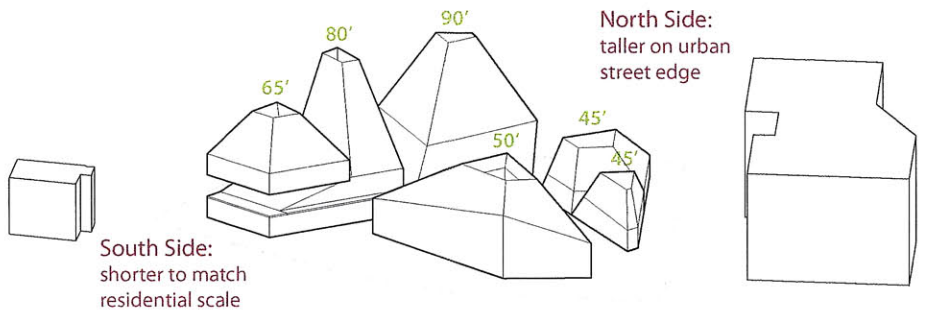
FINAL DESIGN
The Wall

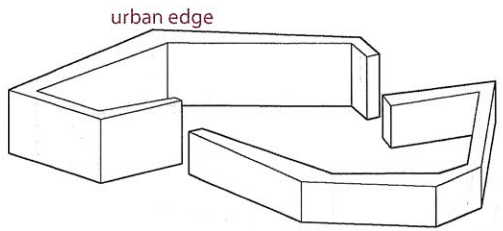
The wall acts as a girdle to hold the open interior of the building in place. It has three major functions: urban, environmental, and programmatic.

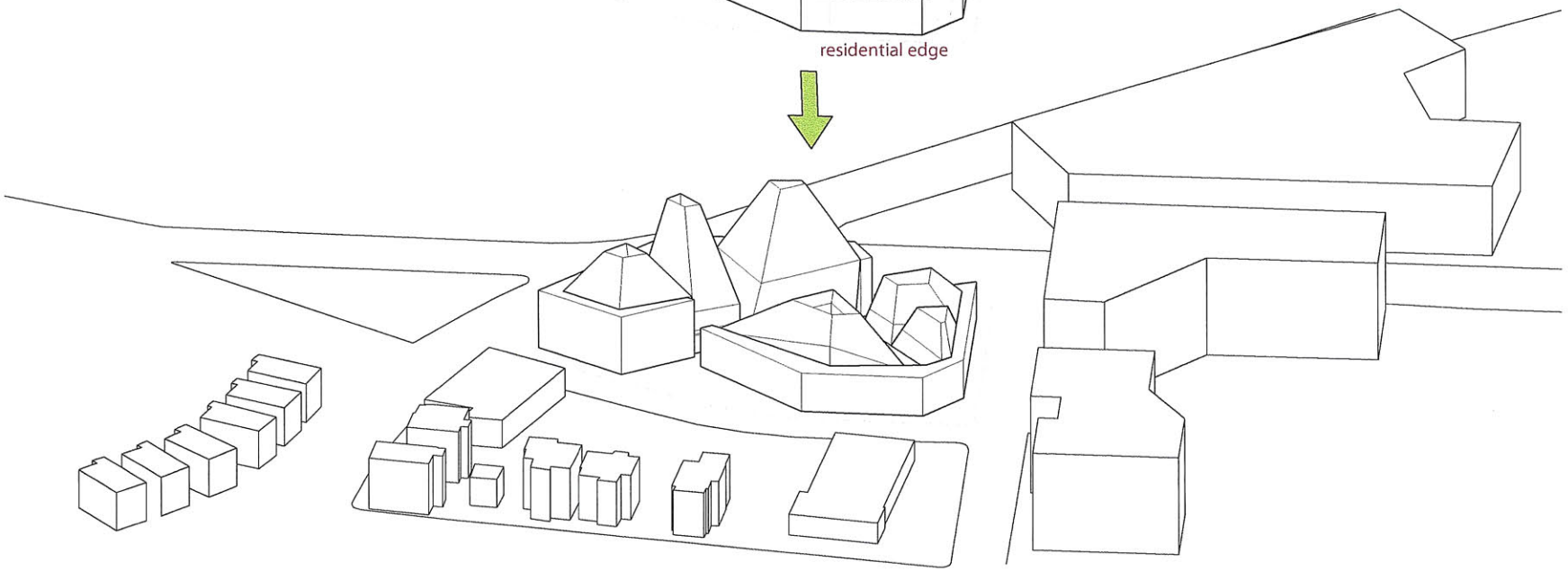
The wall surrounds the entire building, apart from the two openings that function as entries. On the north side, along Western Avenue, the wall raises to 45' in height. It relates to the urban edge and speaks to the scale of the Behnisch Science Complex next door. As the building approaches the residential edge to the south, the wall drops down to 30' to relate to the scale of the houses.

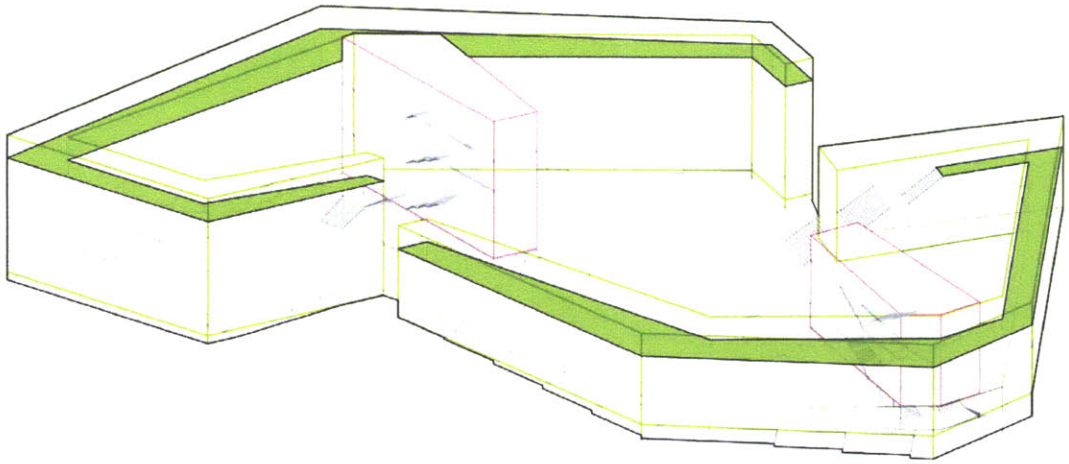
Environmentally, the wall acts as an intermediary space between 'in' and 'out'. It can be seen as an extended air gap that connects to all the funnels and allows for an environmental cushion between the extremes.

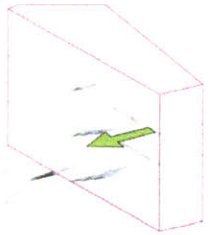
The wall can be used as a circulatory space that moves around the funnels and offers connections between them. It serves as a private relaxation space. The only access to the interior of the wall is from the changing rooms, so it acts as a private space that users can enjoy while being undressed. In the winter the south wall can be used as a sun space, while in the summer the north wall can be used as a cool, shady space. The uses within these spaces change over the course of the day and across the changing seasons. This space reacts according to external conditions as well as internal conditions within the building. The roof of the wall offers an occupiable roof garden that can be enjoyed throughout the year. The height allows for a view of Allston, as well as a moment to meander through the forest of funnel tops that reach up through the building.


80'
90'
65'
50'
45'
45'
North Side:
taller on urban
street edge
South Side:
shorter to match
residential scale


urban edge
residential edge



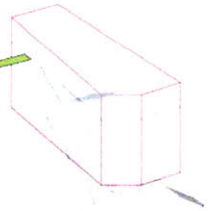


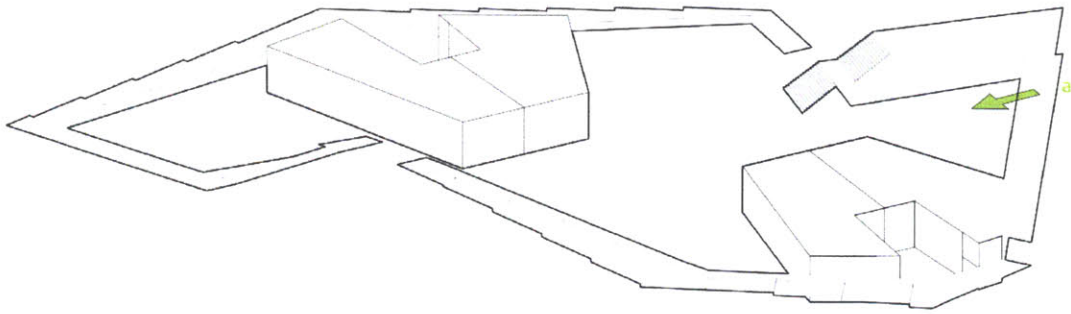


access aquatics

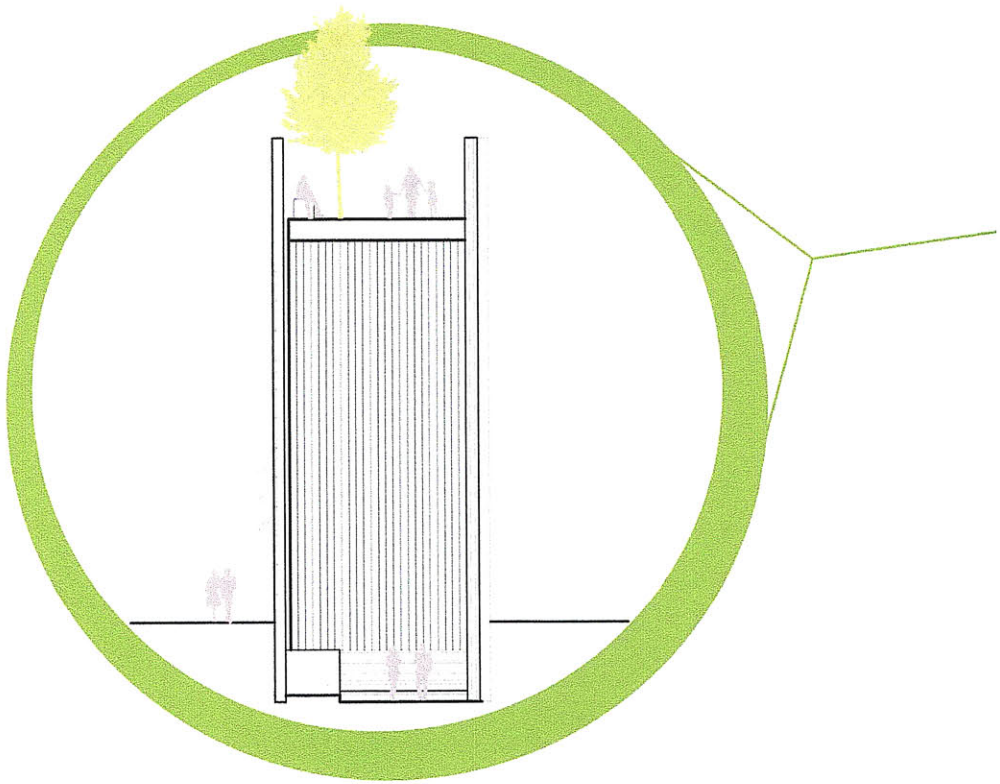
private wedges_ access to
changing rooms and private
wall-winter garden & sun space

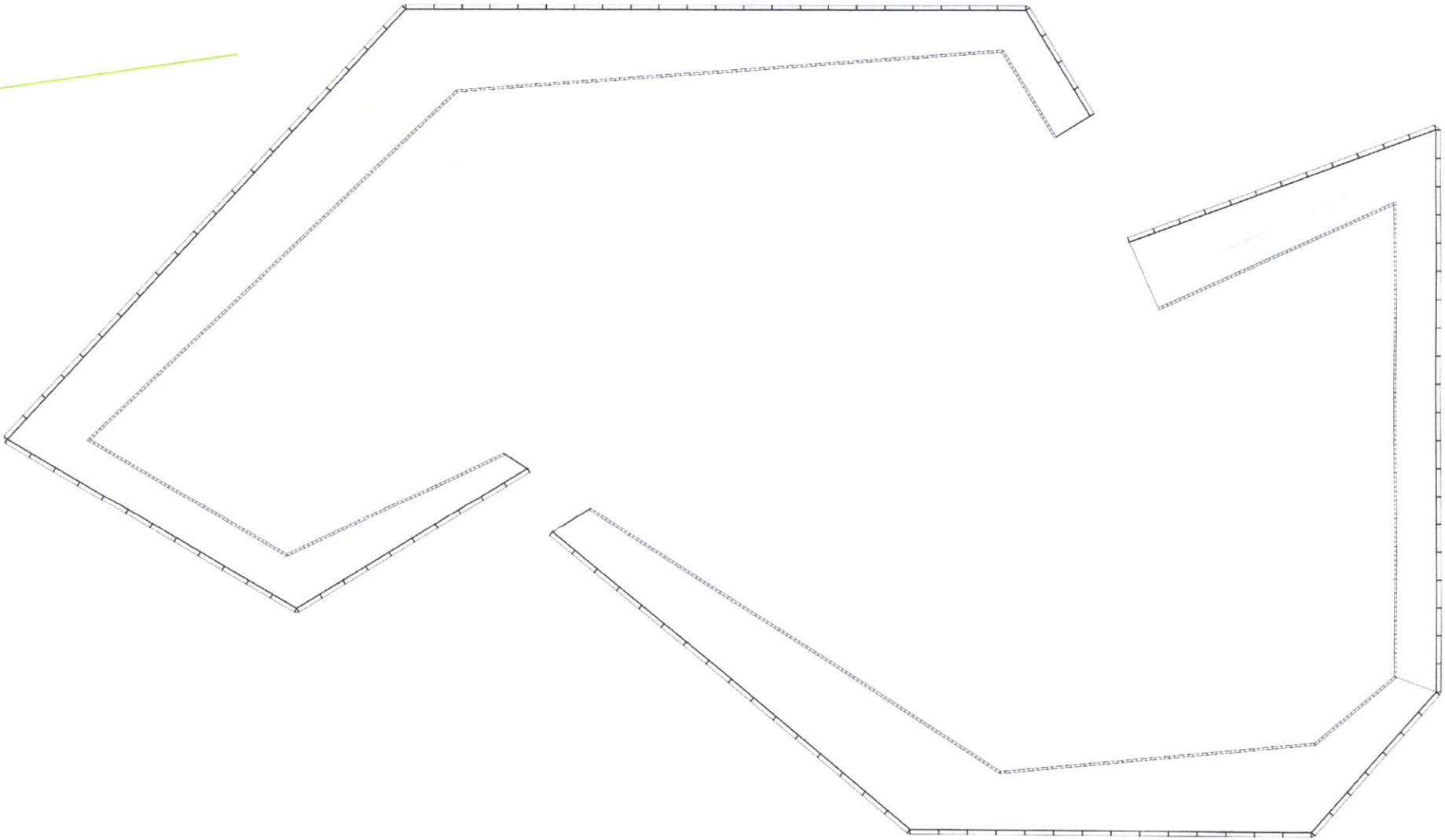
access fitness





access wellness





Interior render from main entrance looking through into central atrium space

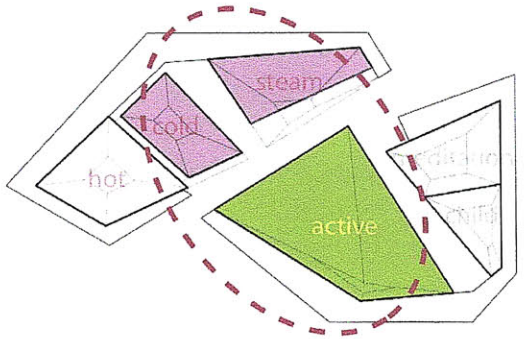
FINAL DESIGN

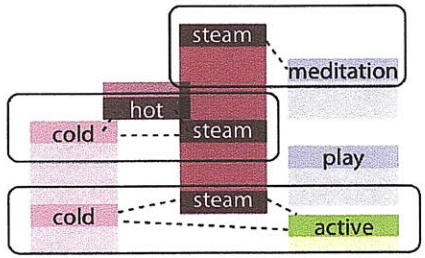
The Funnels

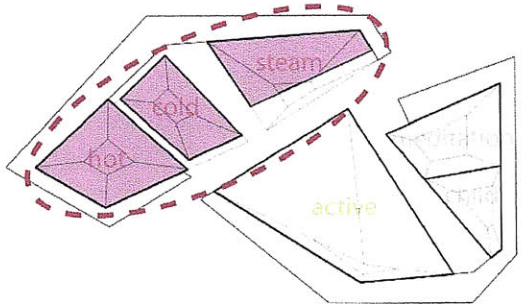
There are six funnels; they are named: steam, cold, hot, meditation, play, and fitness. Just as a clarification, the name does not mean there is a singular interior temperature or environmental quality. The names are for ease of understanding: a sort of diagram that can move throughout. Within each of these funnels, there are smaller subspaces that are controlled for more specific extreme environments, as well as a gradient of temperature changes that occur throughout the funnel.

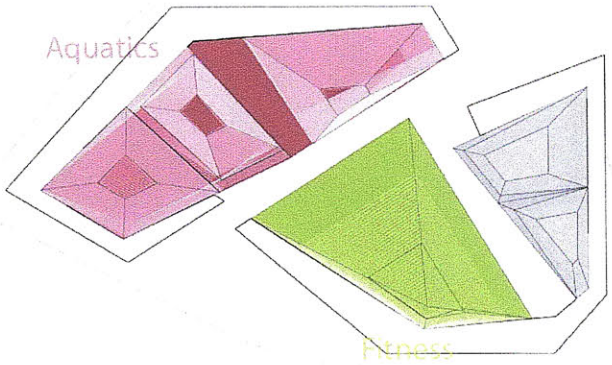
Each funnel is treated the same for a visual clarity that runs throughout. They are made of a diagrid structure that is covered by a twisted, horizontal cladding. The cladding opens up and closes to different degrees depending on privacy, light, and temperature. In specific areas they become louvres and can be moved according to need.

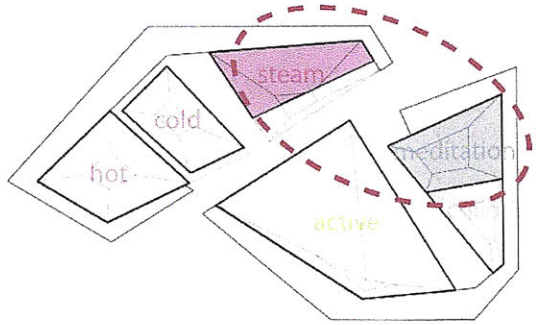

3 categories: Aquatics Fitness Wellness
sub-categories: Hot Active Meditation
Cold Play
Steam

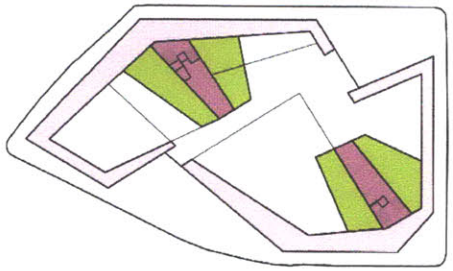

steam
cold
hot
active


steam
meditation
hot
cold
steam
play
steam
cold
active

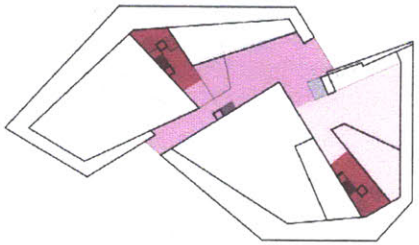

steam
cold
hot
active


Aquatics
Fitness

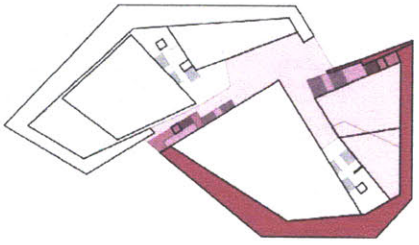

steam
cold
hot
active



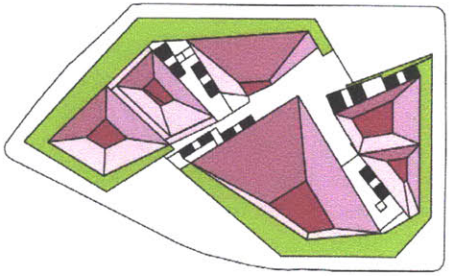
private_ undressed realm
private vertical circulation
wedges



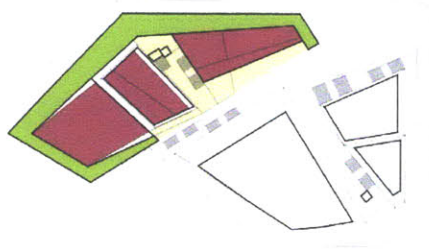
public circulation_ ground
level
private wedges spur off of
central space



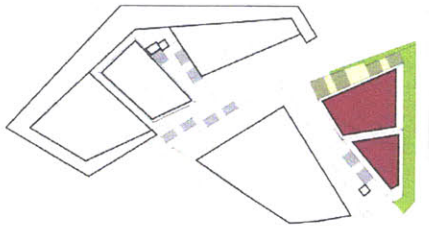
public path_ vertical
circulation leads up to
public spectator areas and
to roof garden



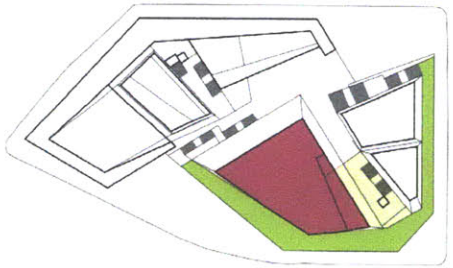
walls hold program
clusters together



private_ aquatics

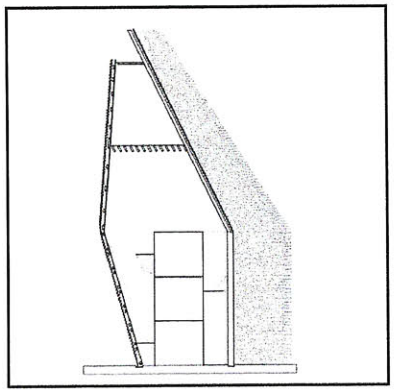


private_ wellness



private_ fitness

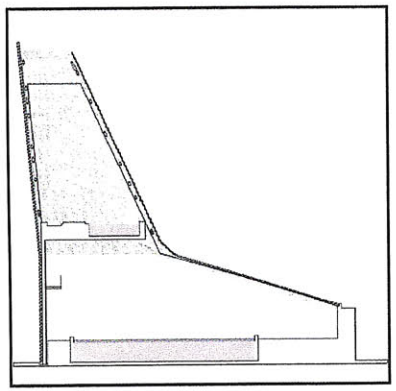
temperature cold hot humidity dry wet



"Steam"

temperature	100° F - 212° F
humidity	40% - 100%
size (footprint)	2400 sq-ft
height	110′
use	disrobing, steam, sauna, hammam, solarium

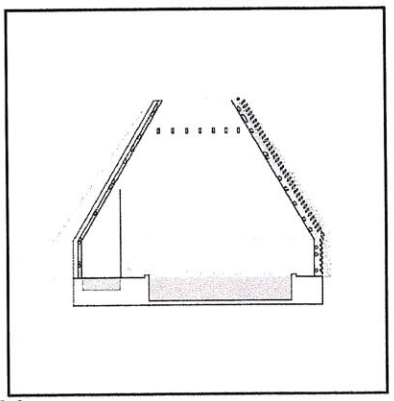
The "steam" funnel is the largest volume of the funnels. The funnel is a warm space that is used as the circulation and disrobing areas. It wraps the steam, sauna and hammam, which are smaller and hotter spaces, which are mechanically controlled to be 100° F - 212° F and have specific relative humidities. At the top of the funnel is the solarium, which is hot and sunny.



"Cold"

temperature	50° F - 75° F
humidity	60%
size (footprint)	5800 sq-ft
height	86′
use	lap pool, cool-down room, cold immersion pool, cool soaking pool, cool showers

The "cold" funnel is the other large volume of the funnels. It has two very different types of cold. The bottom space is cooler because it is a more active space and is connected to the fitness funnel. It contains the lap pool and cooling-down areas. The top space is warmer because it is for relaxation and is connected to the spa. The water temperatures occur within a range of cold to tepid.



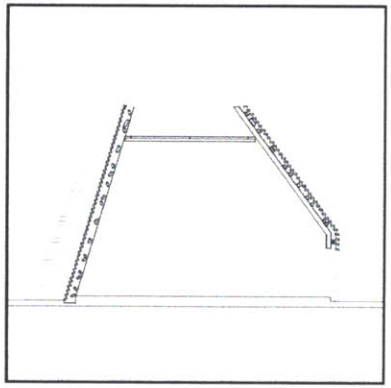
"Hot"

temperature	80° F - 113° F
humidity	35%
size (footprint)	3000 sq-ft
height	44′
use	hot immersion, extended soaking, warm exercise pool, warm leisure areas

The "hot" funnel is on of the shorter funnels, in order to keep the hot air closer to the occupiable space of the pools. The funnel itself floats higher within the atrium space so that the air surrounding it is warmer and it has more access to the sun. Within the space there are a range of air and water temperatures ranging between 80° F - 113° F.

size (footprint) small — big

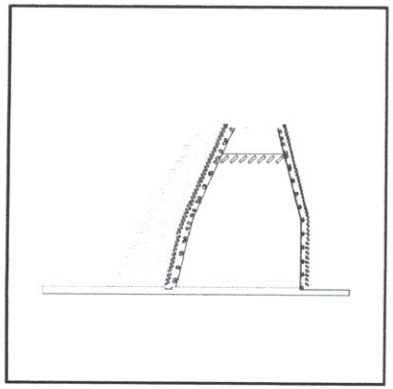
height short — tall



"Meditation"

temperature	75° F - 90° F
humidity	45%
size (footprint)	2400 sq-ft
height	42'
use	meditation, yoga, pilates, massage, chiropractic, acupuncture

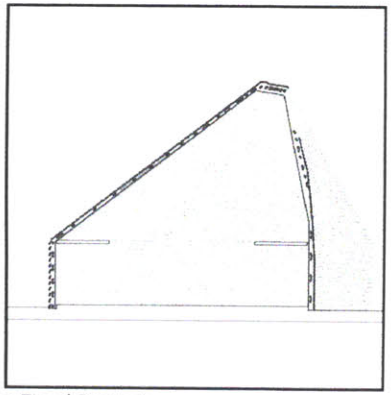
The "meditation" funnel is used for a variety of uses related to wellness: meditation, yoga, pilates, massage, chiropractic and acupuncture. It can be used by individuals or by a small group. It can also be used to practice or to teach.



"Play"

temperature	70° F - 75° F
humidity	45%
size (footprint)	1400 sq-ft
height	35'
use	children's play area, child care

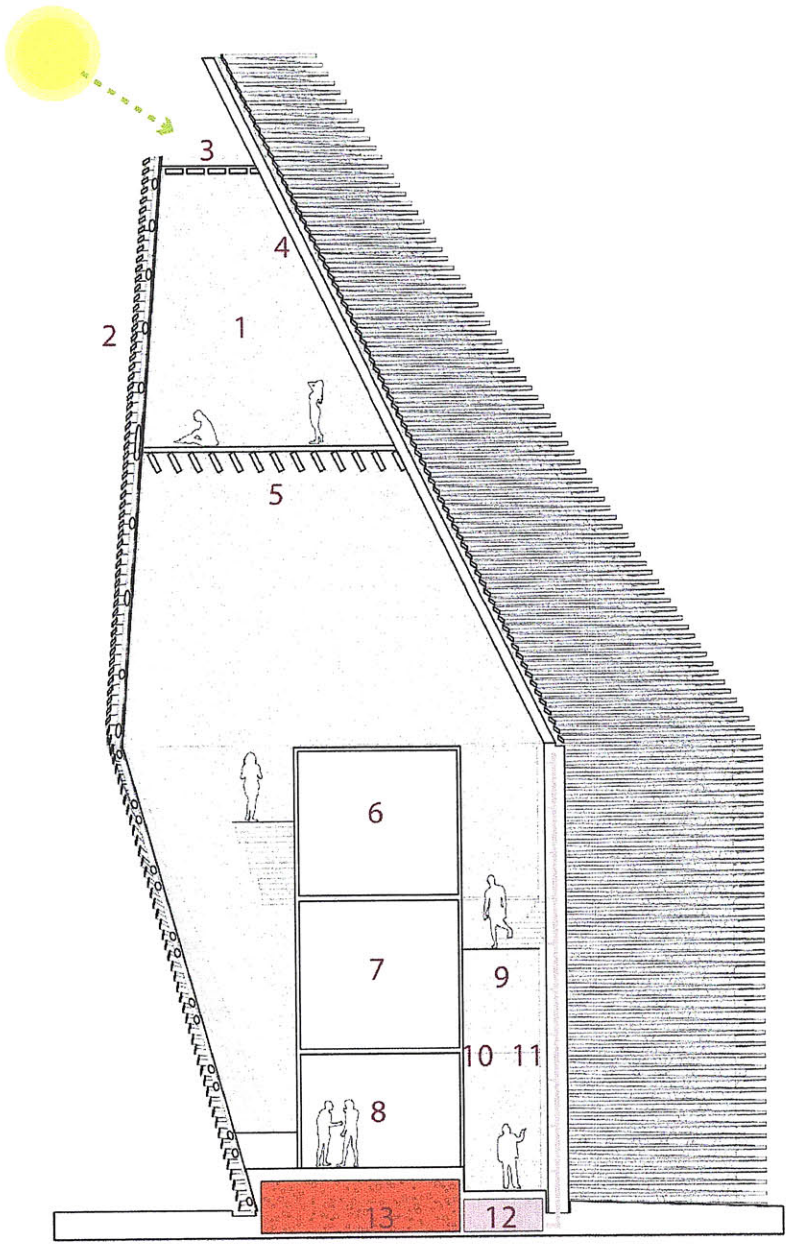
The "play" funnel is the smallest volume of the funnels. It is scaled for children, as it is the children's play area.



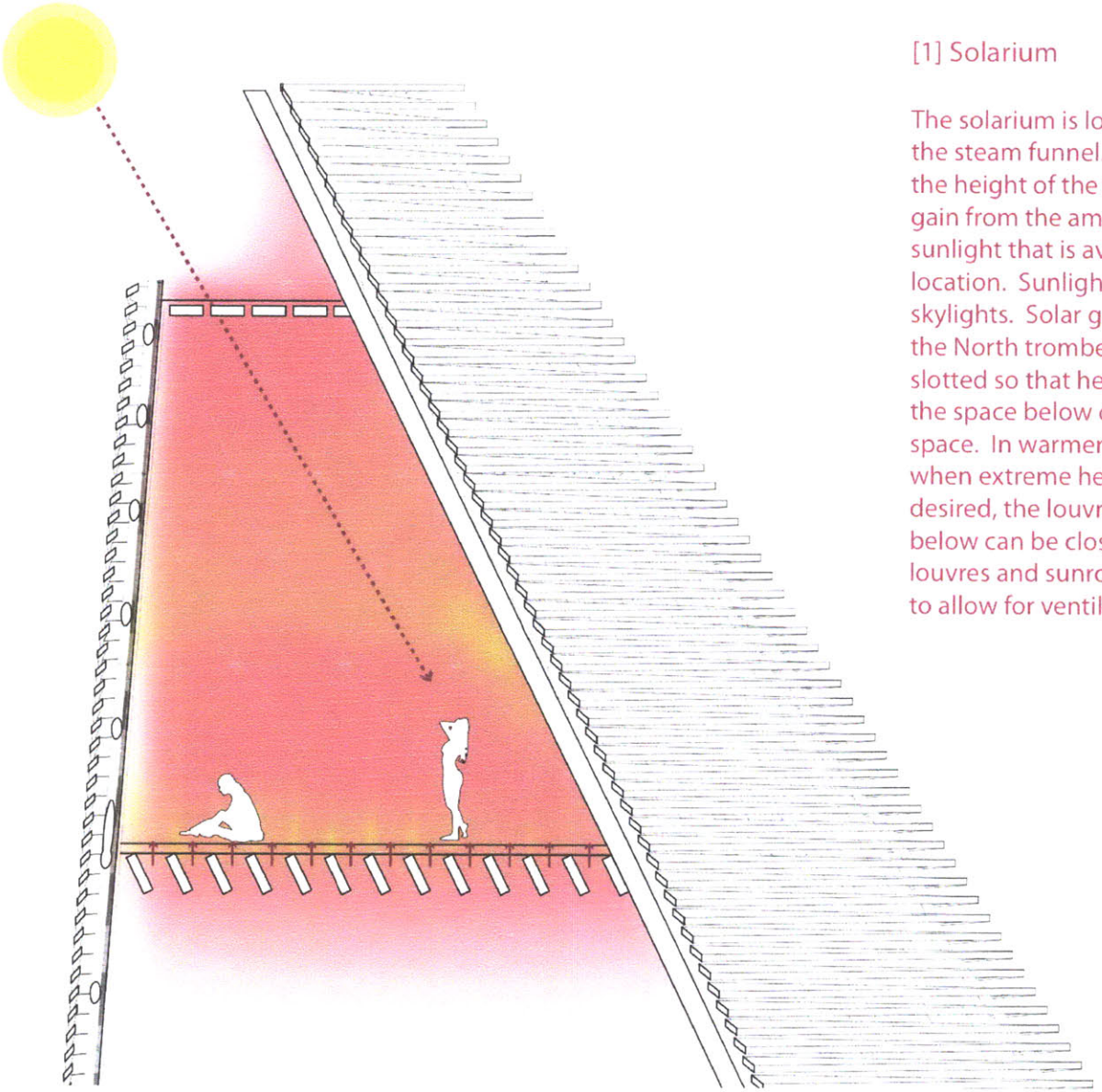
"Fitness"

temperature	65° F - 75° F
humidity	38%
ventilation	10-13 mph from the West
size (footprint)	7400 sq-ft
height	67'
use	activity court (ie basketball), changing rooms, track

The "fitness" funnel is a well-ventilated space that is used for highly active functions, such as a running track and an activity court, for games such as basketball. It also has a public spectator component so that the community can be brought in for games.



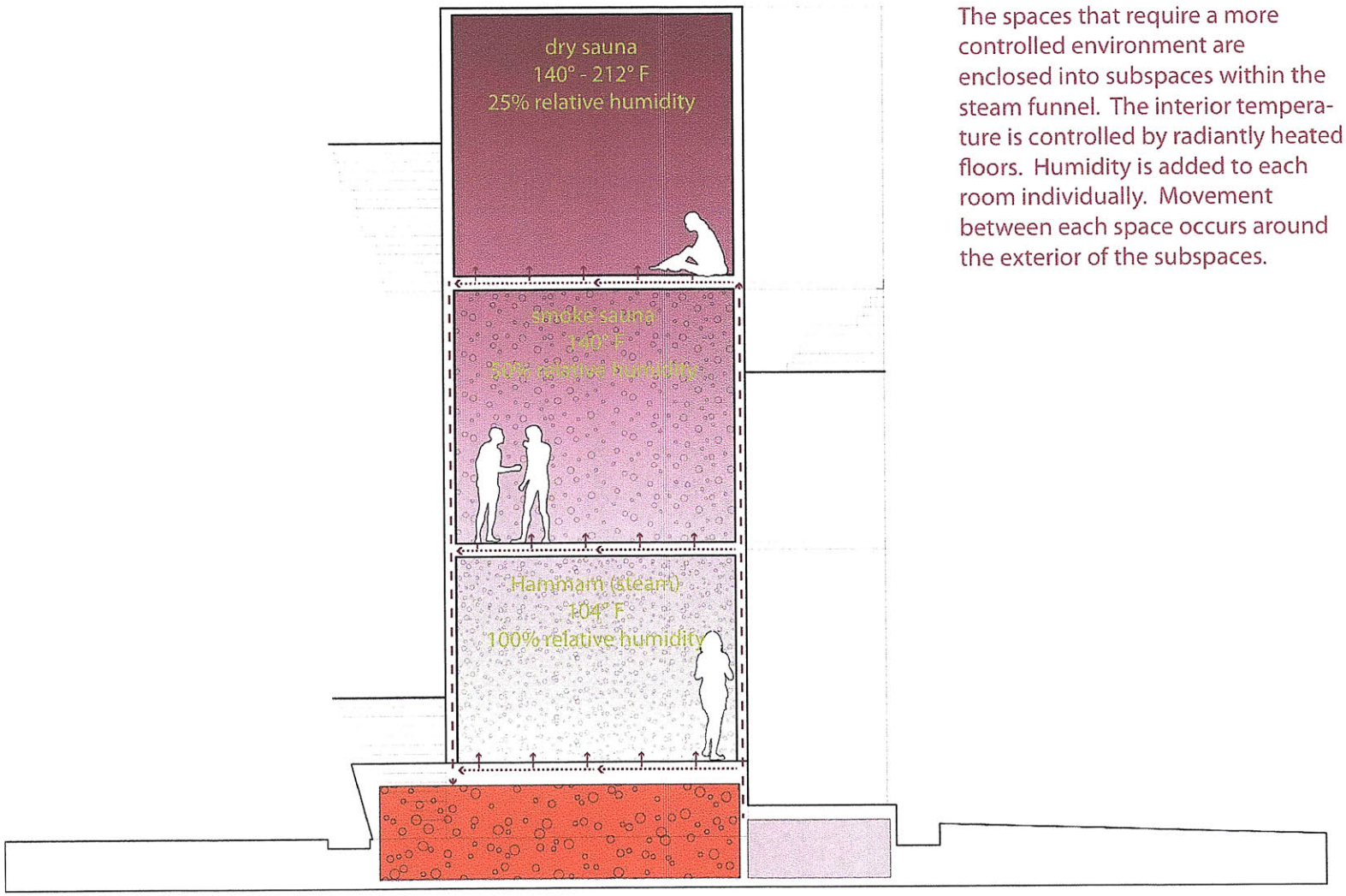
1. *Solarium*
2. Operable louvred wall system
3. Skylight to allow in sunlight
4. Thickened, opaque wall on the South side to act as a solar collector to radiate heat back into space.
5. Louvres can be opened to allow heat collecting in upper space to empty into Solarium in colder winter months
6. *Dry Sauna*
7. *Smoke Sauna*
8. *Hammam / Steam*
9. *Steam Corridor*
10. Radiant Heated Enclosure
11. Steam Wall: Opaque, thickened North wall carries water up and sprays a mist into warm corridor and onto hot wall, creating the steam corridor
12. Water Tank
13. Mechanical heating systems



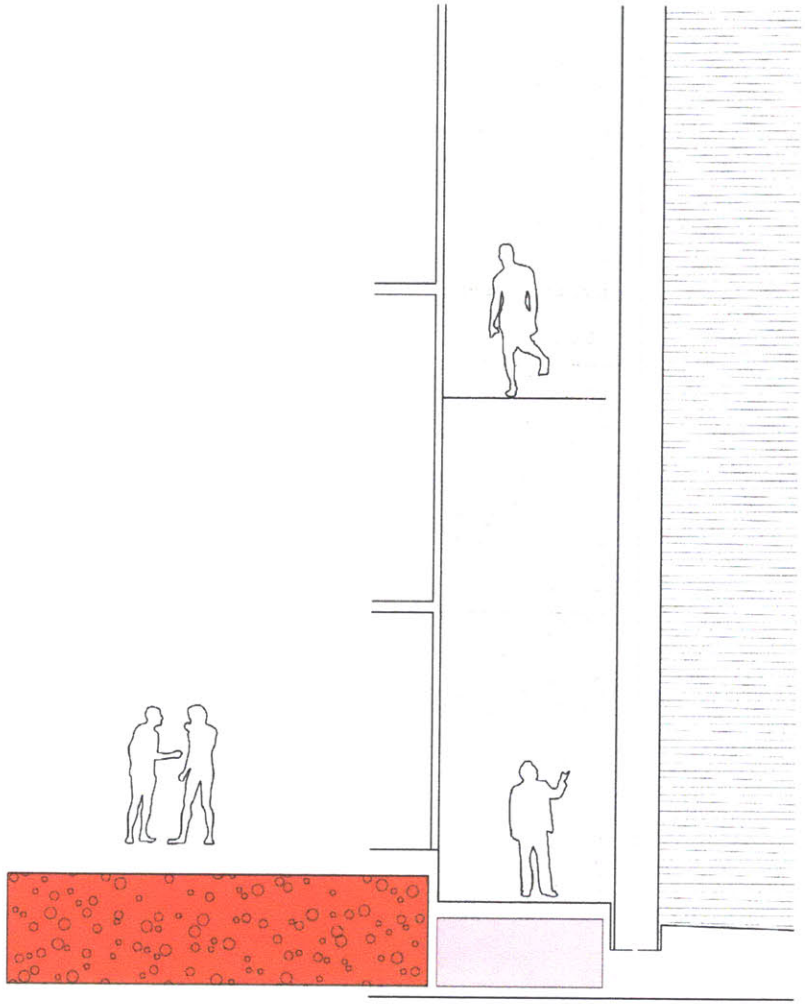
[1] Solarium

The solarium is located in the top of the steam funnel. It benefits from the height of the funnel with solar gain from the amount of direct sunlight that is available at this location. Sunlight penetrates the skylights. Solar gain is collected by the North trombe wall. The floor is slotted so that heat that rises from the space below can enter into the space. In warmer summer months when extreme heat gain is NOT desired, the louvres to the space below can be closed, the side louvres and sunroof can be opened to allow for ventilation of the space.

[6 / 7 / 8] Sauna / Steam

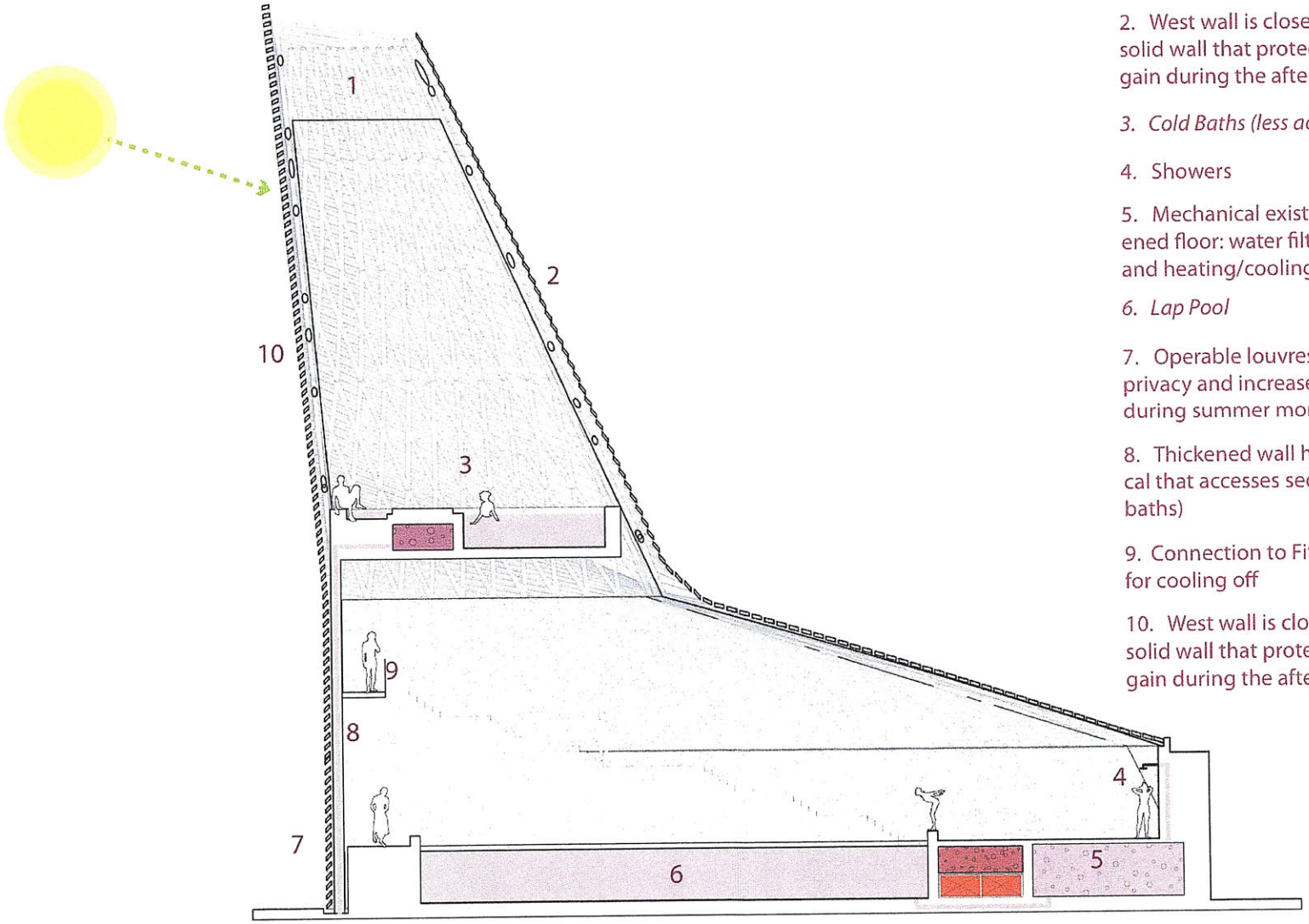


The spaces that require a more controlled environment are enclosed into subspaces within the steam funnel. The interior temperature is controlled by radiantly heated floors. Humidity is added to each room individually. Movement between each space occurs around the exterior of the subspaces.



[9] Steam Corridor

This is the circulation that allows movement between the steam and sauna rooms. The space moves in-between the exterior funnel wall and the interior saunas. Water is brought up through pipes hidden in the wall, and a fine mist is sprayed into the air. The radiant heated walls of the sauna create steam as the mist lands on the surface. The steamy corridor allows for a degree of privacy as visitors can move undressed between the sauna and steam rooms.



1. Heat that rises due to stack effect is collected, cycled back down, and reused to heat lap pool.

2. West wall is closed creating a solid wall that protects against solar gain during the afternoon hours.

3. *Cold Baths (less activity)*

4. Showers

5. Mechanical exists within thickened floor: water filtration system and heating/cooling systems

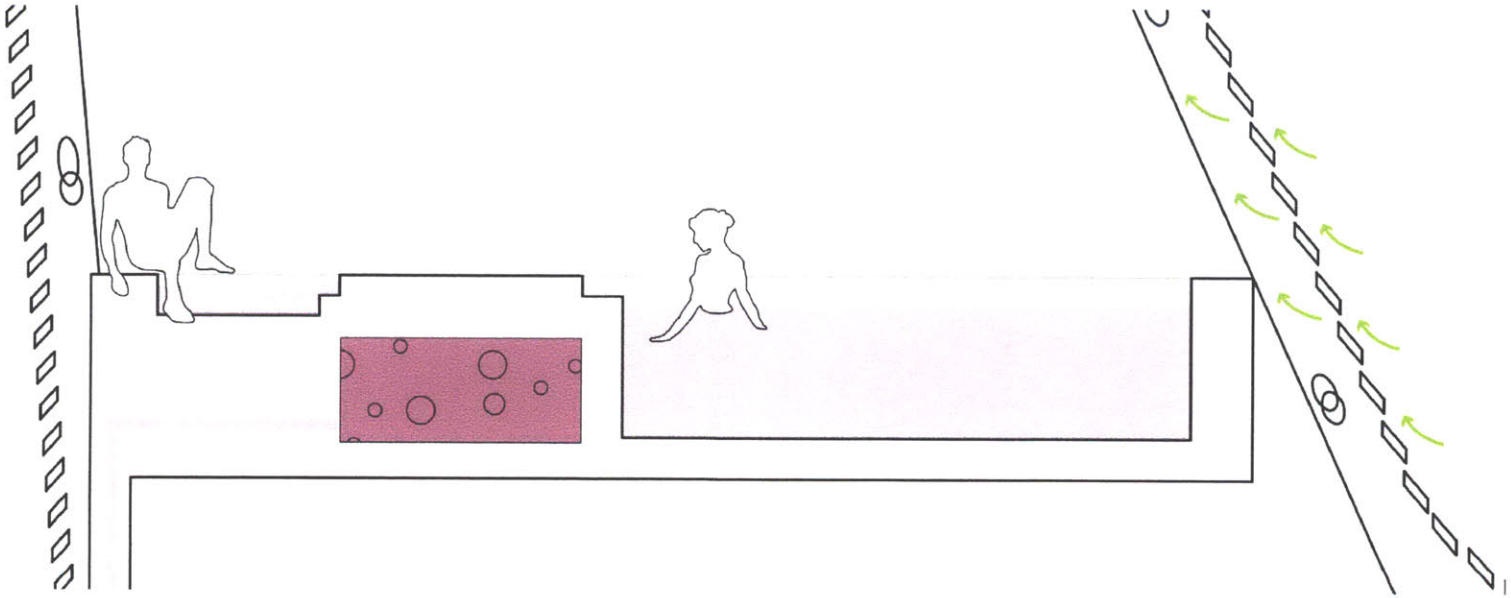
6. *Lap Pool*

7. Operable louvres allow for both privacy and increased ventilation during summer months

8. Thickened wall houses mechanical that accesses second floor (cold baths)

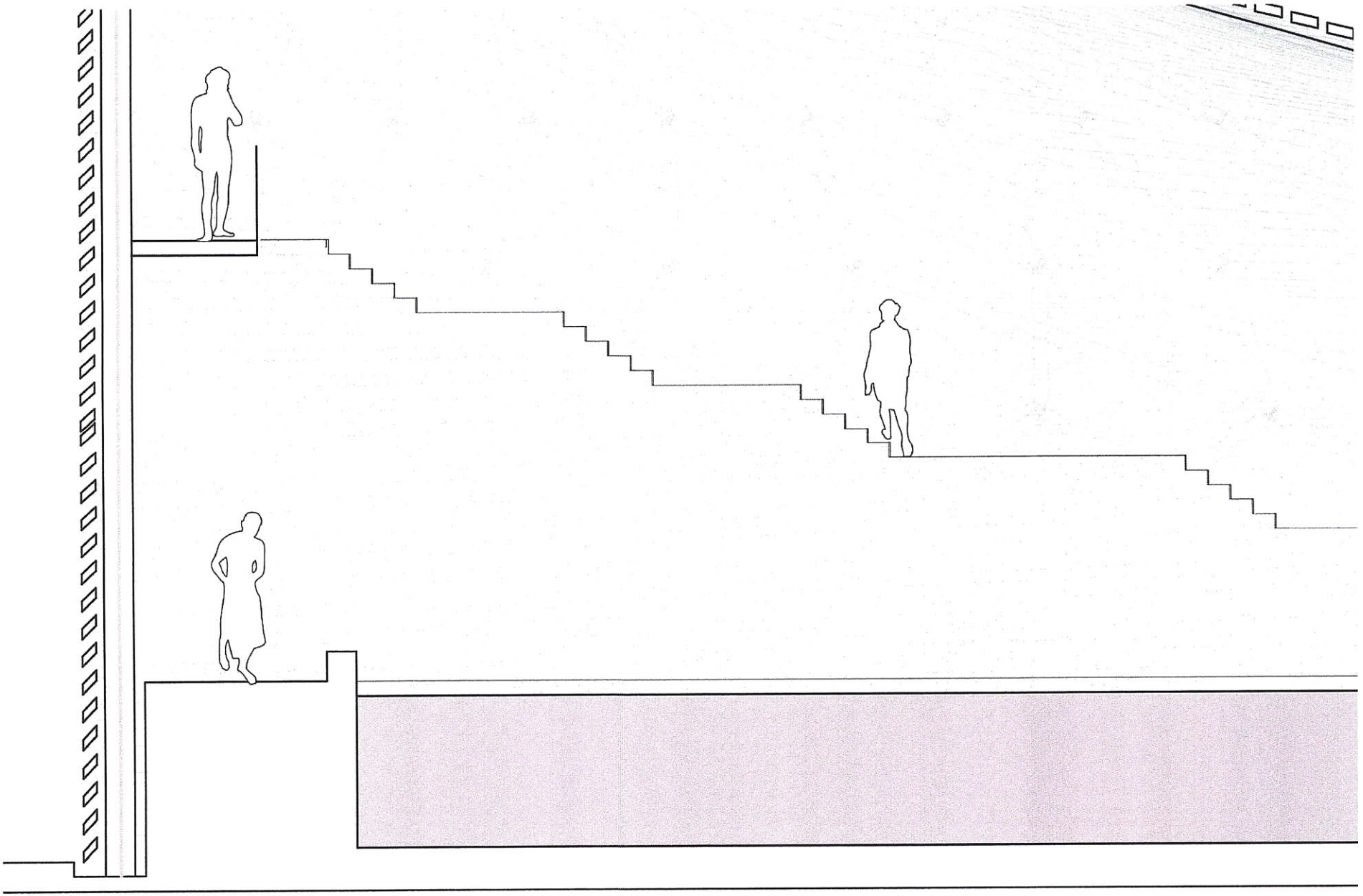
9. Connection to Fitness area; space for cooling off

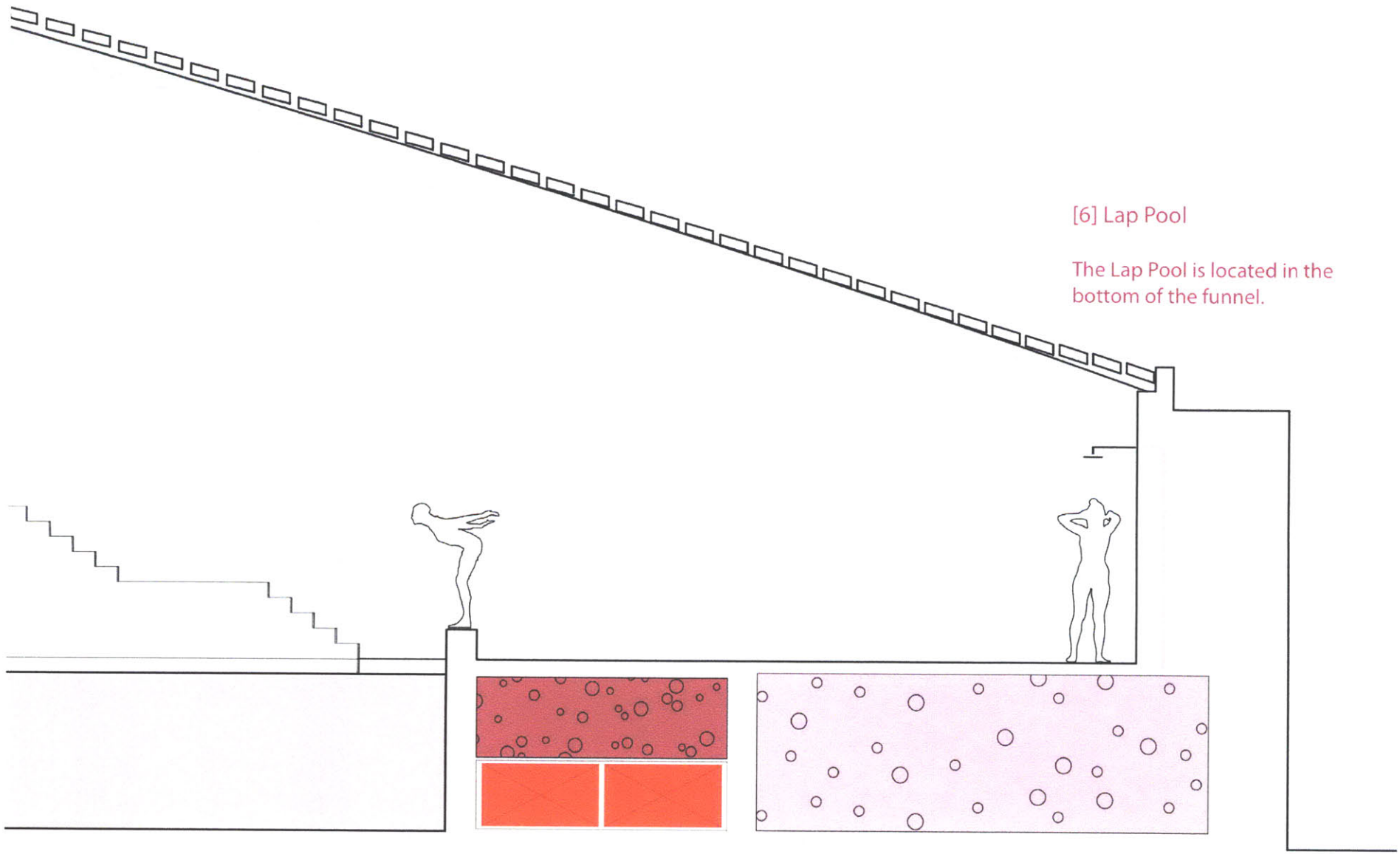
10. West wall is closed creating a solid wall that protects against solar gain during the afternoon hours.



[3] Cold Baths

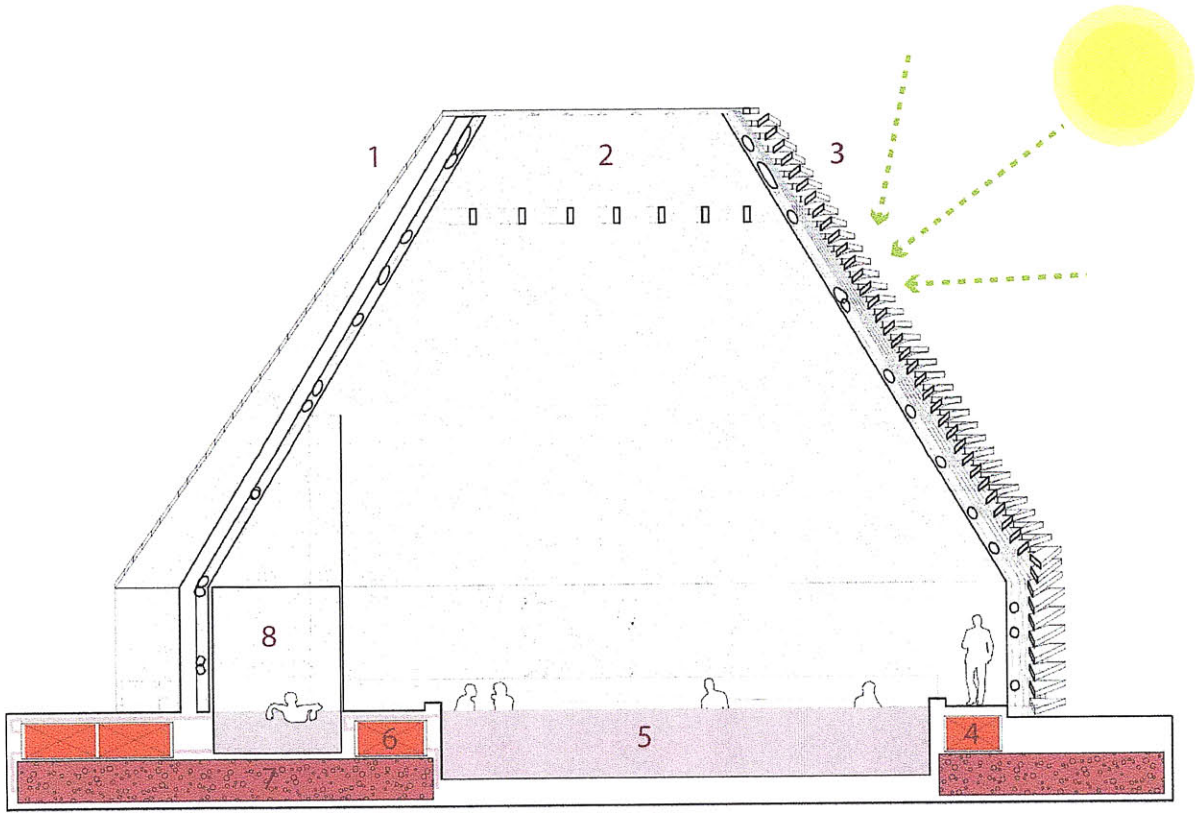
The Cold Baths are located in the middle section of the Cold Funnel. The pools are a range of temperatures that are mechanically controlled. Because of its location within the funnel, the air is warmer than at the base. During extremely cold winter months, the space is warmed to an agreeable temperature. During extremely hot summer months, the space is ventilated to naturally cool the air.





[6] Lap Pool

The Lap Pool is located in the bottom of the funnel.



1. North wall is a thick, opaque wall to keep from losing heat during the winter months and at night.

2. Skylights are operable to allow heat to escape when it is too warm during summer months, and to close out sunlight during summer hours when heat gain is beyond desired amount.

3. South Wall is open to allow for heat gain during the full year.

4. Thickened floor is used as mechanical space: it services the water filtration and heating systems. The floor also acts as a thermal heat gain.

5. *Warm soaking pool*

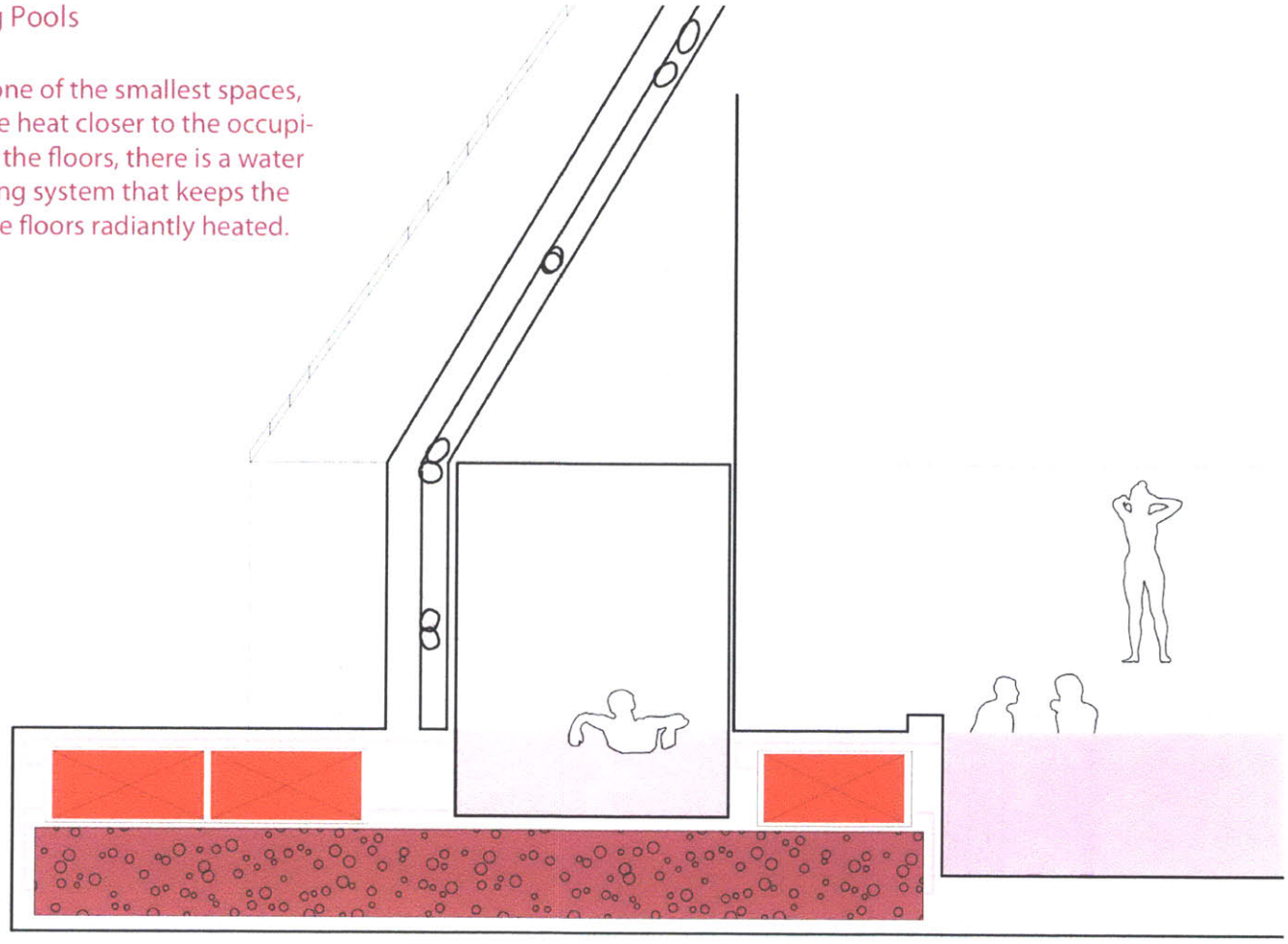
6. Mechanical: heating, which feeds radiant heated floors

7. Mechanical: water filtration system

8. Small, enclosed hot pool

[5] Warm Soaking Pools

The Hot Funnel is one of the smallest spaces, in order to keep the heat closer to the occupiable space. Within the floors, there is a water filtration and heating system that keeps the pools warm and the floors radiantly heated.

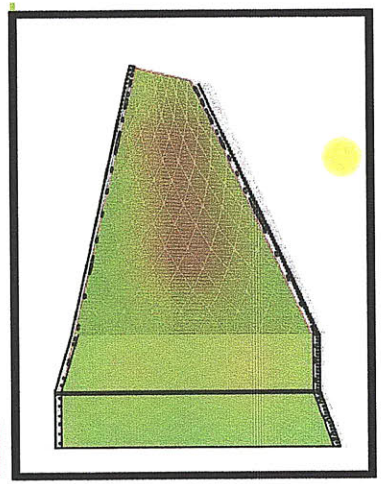


Interior render of lap pool in base of Cold Funnel

Interior render of hot soaking pool in Hot Funnel

January

February

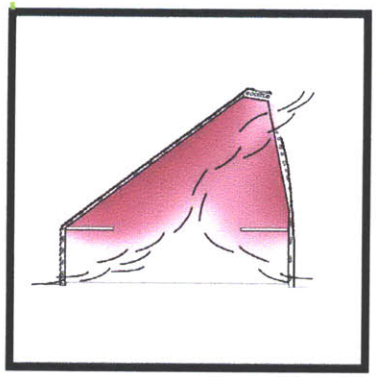


1

Temperature | Daytime

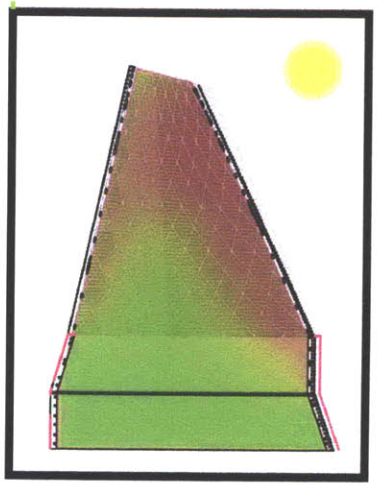
The low sun angle during the winter lets the sun's rays penetrate the Southern facade allowing solar gain on the North wall. As the air heats up in the top portion of the funnel, cold air is brought in through openings in the bottom, creating a chimney effect, thus keeping the space cool.

Equinox



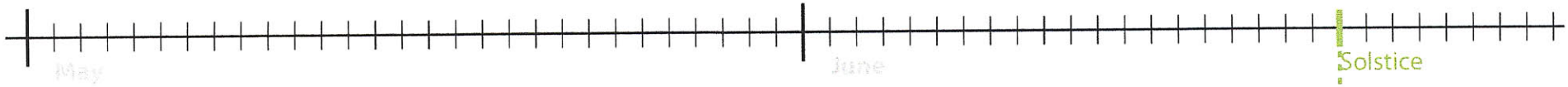
2

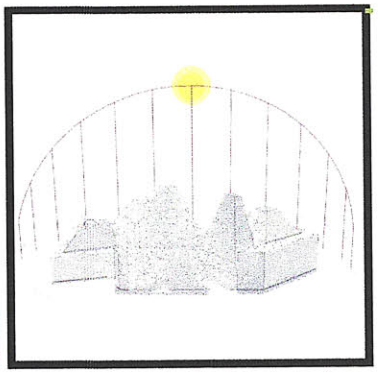
Ventilation
The shape of the volume and the angle of the roof, coupled with the opening at the top of the funnel allows passing winds to maintain airflow throughout the space.



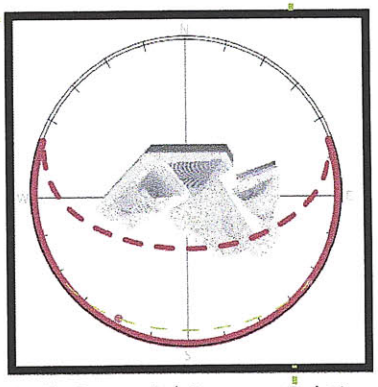
3

Temperature | Daytime
The slatted wall assembly shields direct sunlight from entering the space while collecting solar heat gain. Using the chimney effect, the super heated air in the top portion of the funnel pulls warm air from the exterior which is cooled as it moves across the cold pools in the bottom.

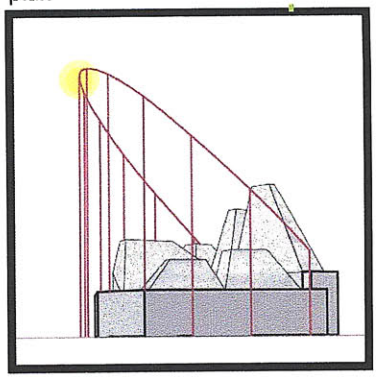




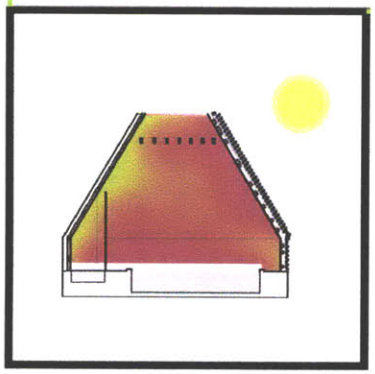
4 Daily Sunpath | Summer Solstice
section



5 Daily Sunpath | Summer Solstice
plan

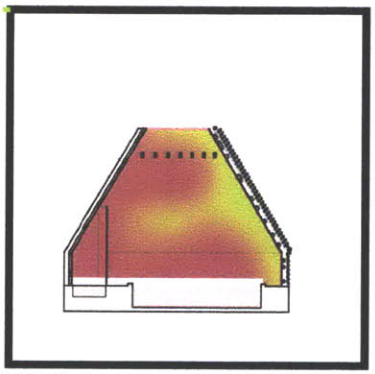


6 Daily Sunpath | Summer Solstice
elevation



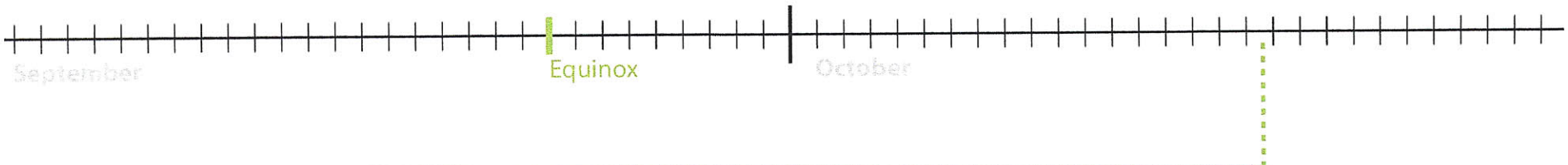
7

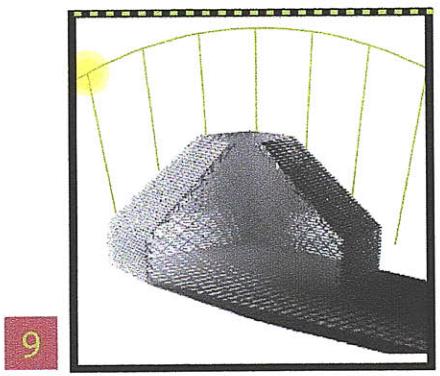
Temperature | Day | Hot pools
Heat in the space is maintained through direct gain from the sun. North wall and floor act as thermal mass that collects heat during the day.



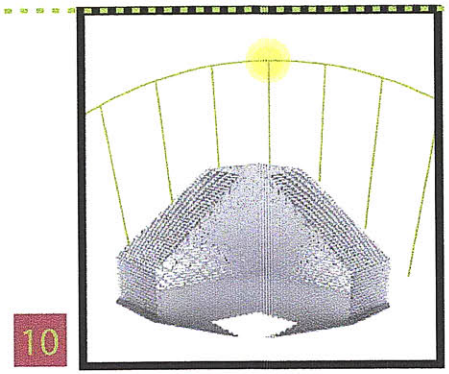
8

Temperature | Night | Hot pools
Thermal heat collected throughout the day in the floors and North wall are slowly released in cooler evening hours to maintain desired heat levels.

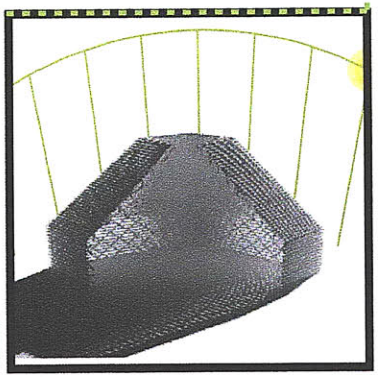




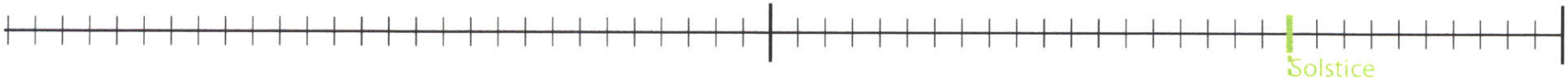
9 Shade Diagram | 9 am

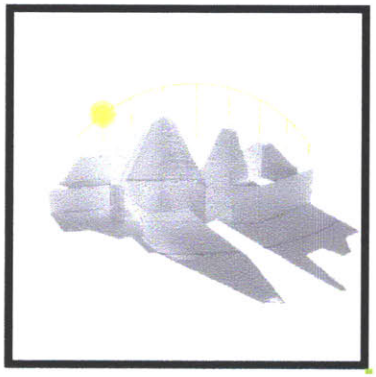


10 Shade Diagram | 12 pm



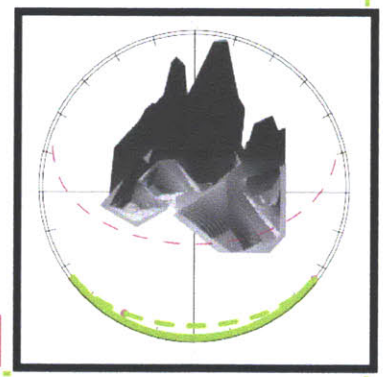
11 Shade Diagram | 3 pm





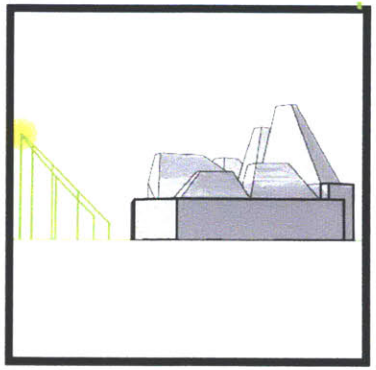
12

Daily Sunpath | Winter Solstice
section



13

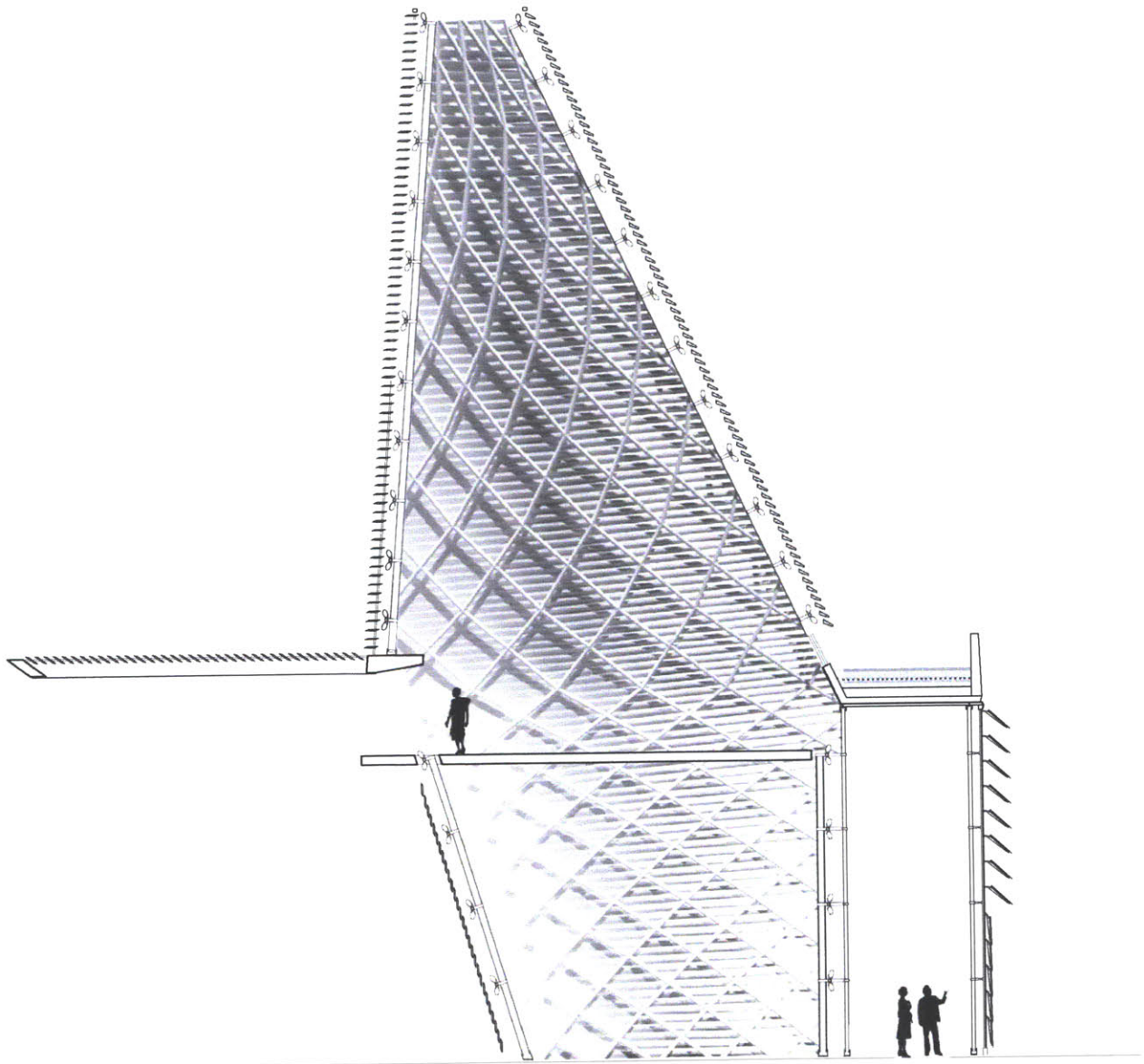
Daily Sunpath | Winter Solstice
plan



14

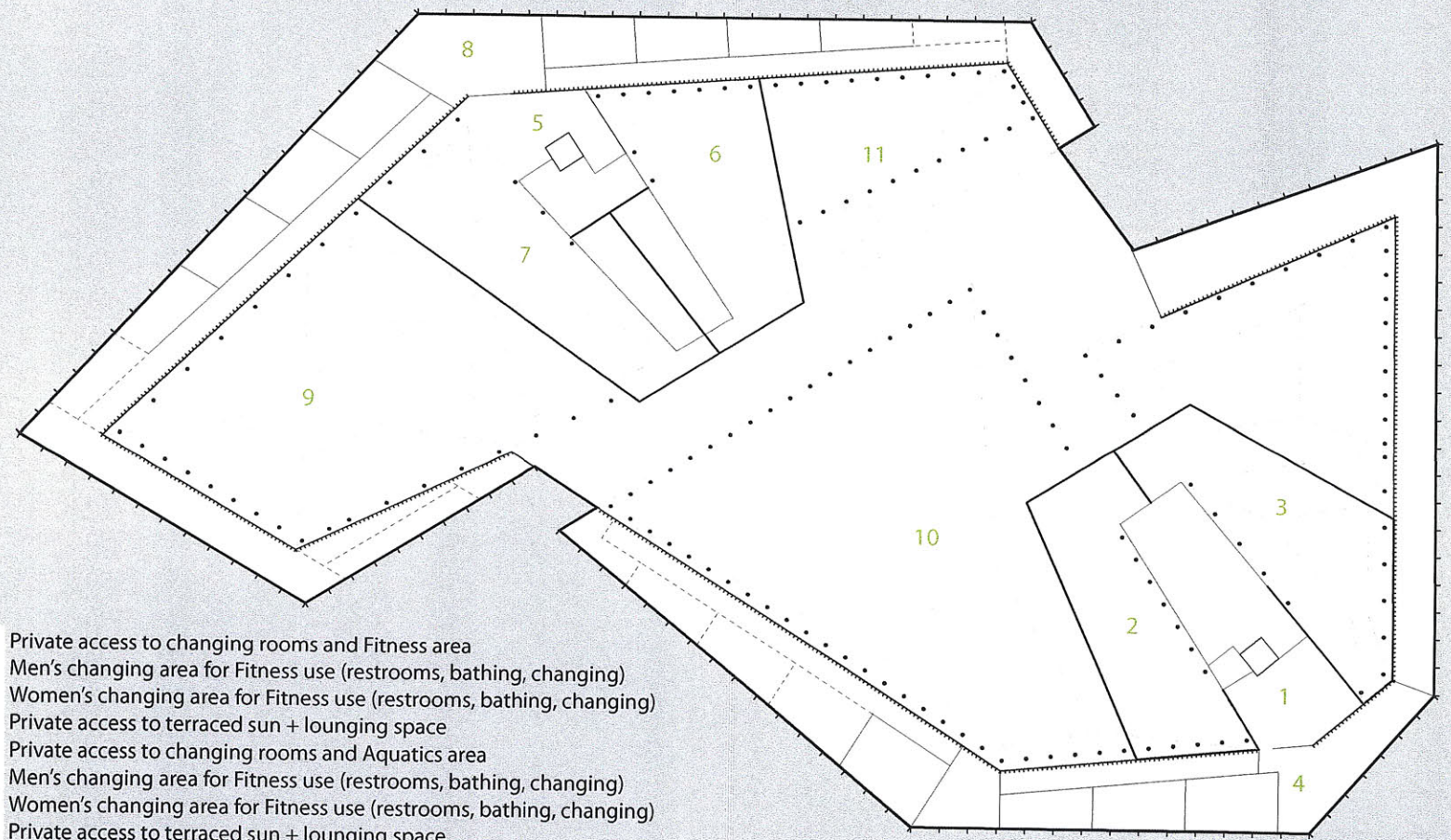
Daily Sunpath - Winter Solstice
elevation

FINAL DESIGN
Plans + Sections



5′ 10′ 20′

The Final Project



1. Private access to changing rooms and Fitness area
2. Men's changing area for Fitness use (restrooms, bathing, changing)
3. Women's changing area for Fitness use (restrooms, bathing, changing)
4. Private access to terraced sun + lounging space
5. Private access to changing rooms and Aquatics area
6. Men's changing area for Fitness use (restrooms, bathing, changing)
7. Women's changing area for Fitness use (restrooms, bathing, changing)
8. Private access to terraced sun + lounging space
9. Mechanical for Aquatics funnels
10. Mechanical for Wellness funnels
11. Mechanical for Aquatics funnels

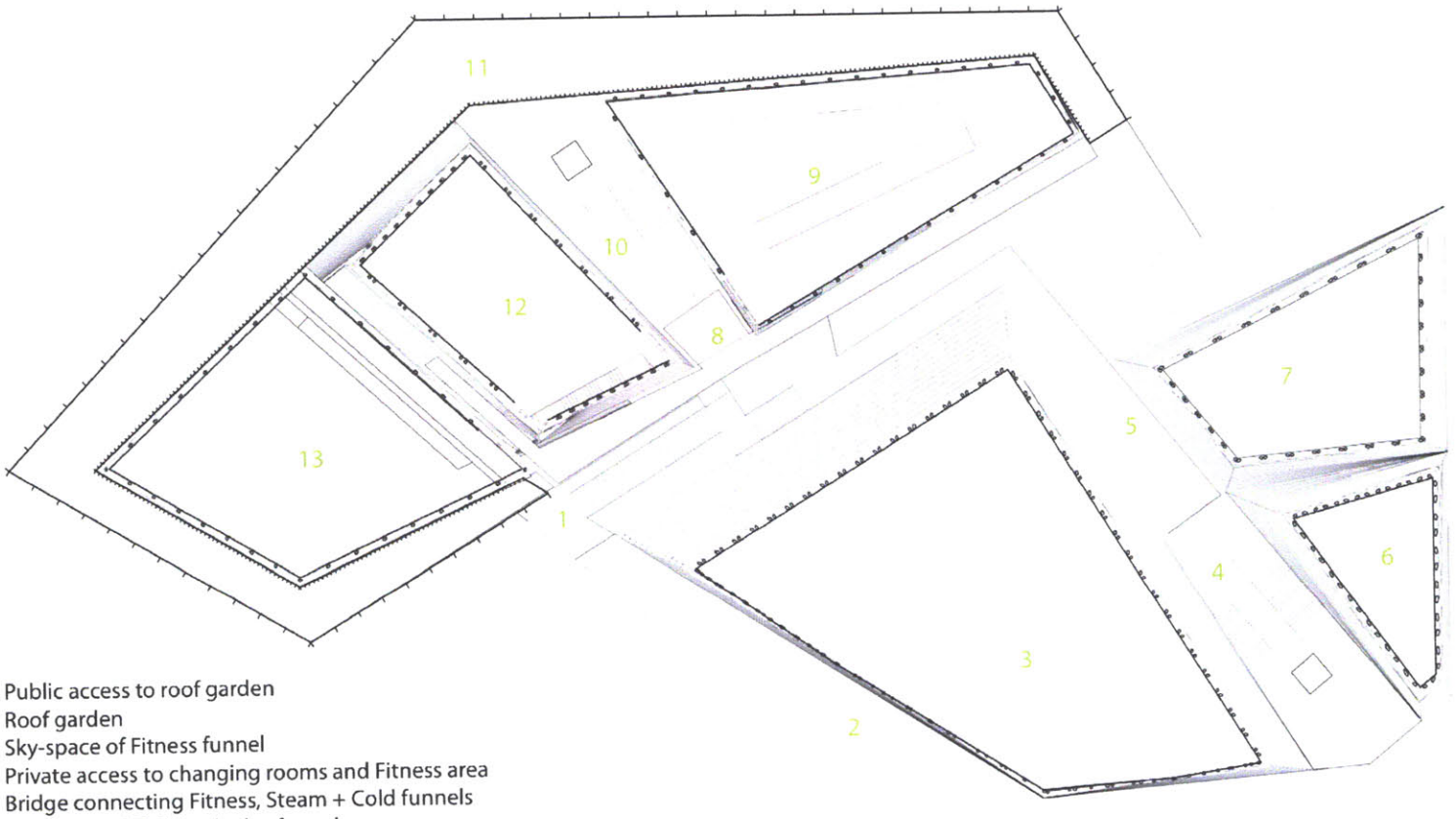
plan 1 -7'

1. Main public entry
2. Lobby
3. Public vertical circulation
4. Stairs to Wellness Area
5. Cafe
6. Private access to changing rooms and Fitness area
7. Private terraced sun space
8. Fitness funnel: basketball court
9. Secondary entry
10. Cold funnel: lap pool
11. Private access to changing rooms and Aquatics area
12. Private terraced sun space
13. Steam funnel

plan 2 +0'

1. Public access to Spectator areas (fitness + ampitheatre)
2. Fitness funnel: indoor track
3. Private access to changing rooms and Fitness area
4. Bridge connecting Fitness, Steam + Cold funnels
5. Children's Play funnel
6. Meditation + Treatment Funnel
7. Access to Wellness area
8. Steam funnel
9. Private access to changing rooms and Aquatics area
10. Cold funnel: cold resting area + stairs down to lap pool
11. Public ampitheatre

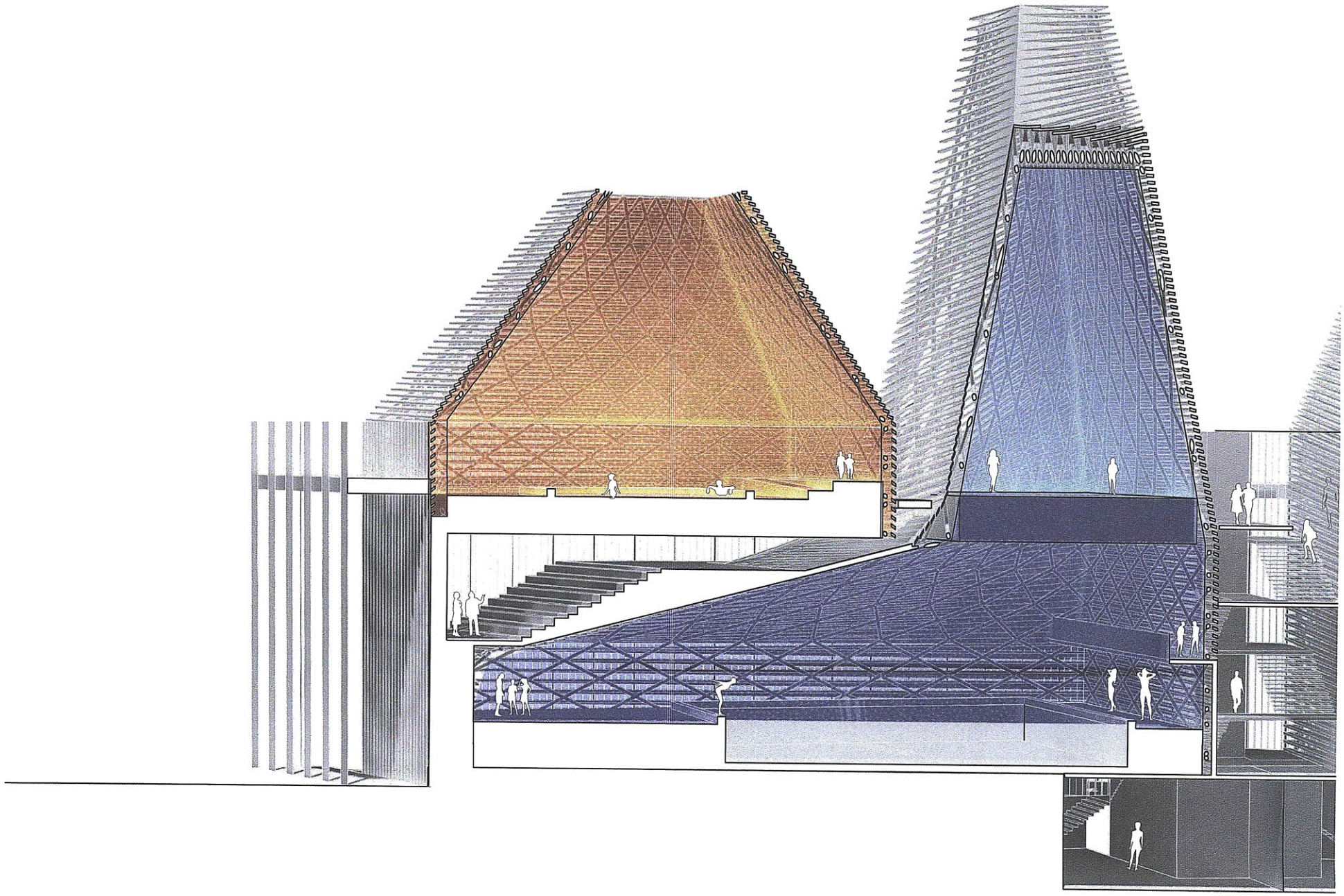
plan 3 +28'

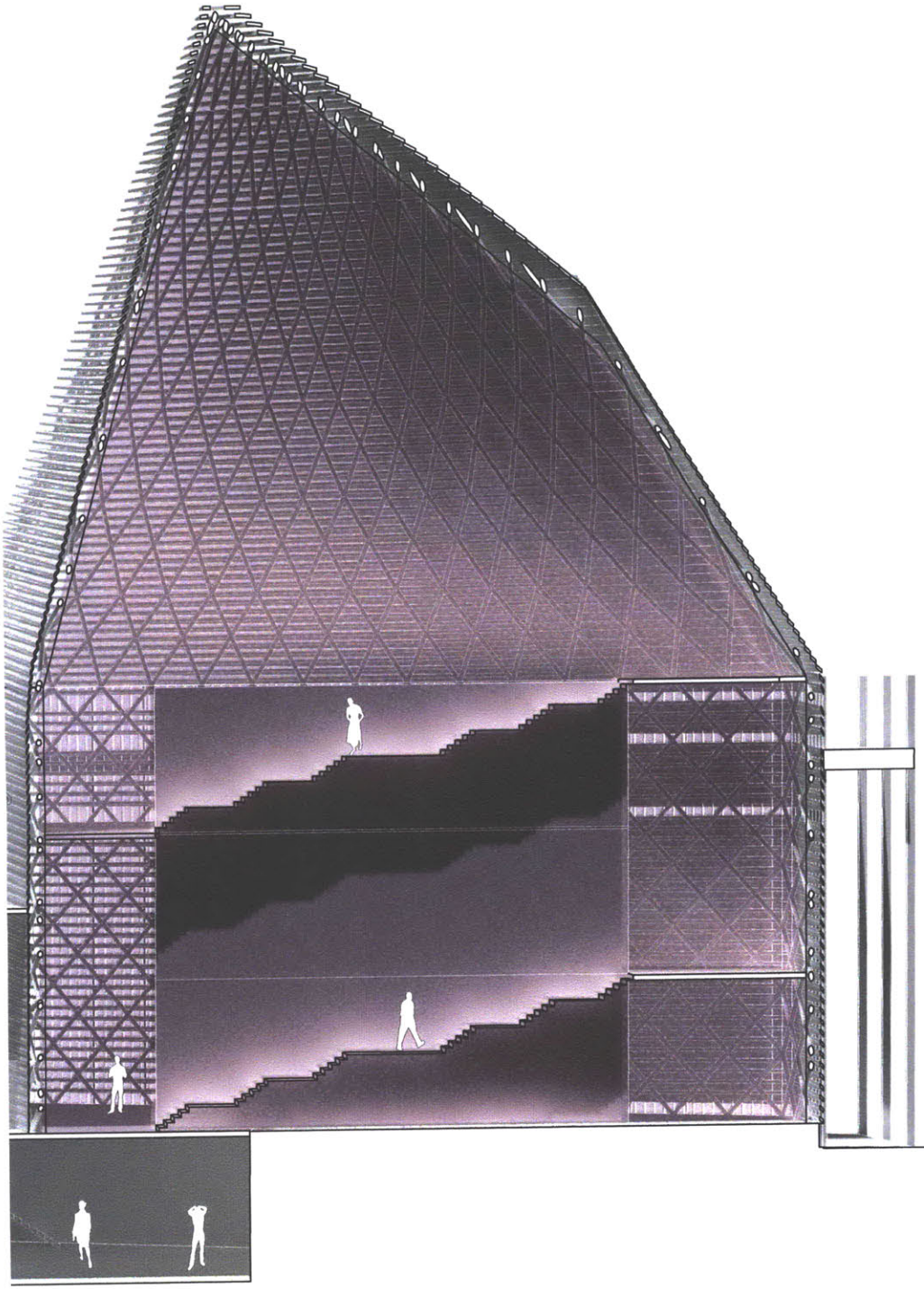


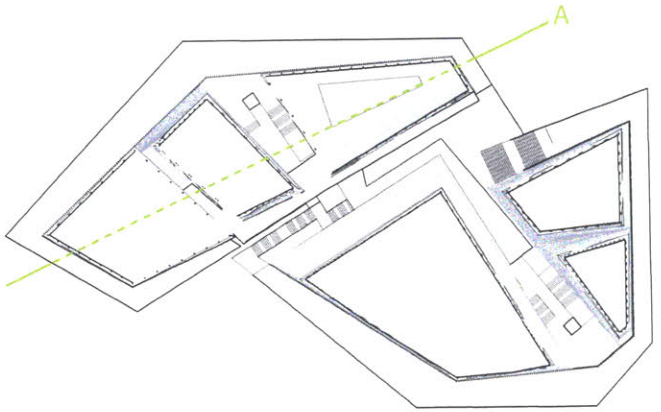
1. Public access to roof garden
2. Roof garden
3. Sky-space of Fitness funnel
4. Private access to changing rooms and Fitness area
5. Bridge connecting Fitness, Steam + Cold funnels
6. Sky-space of Children's play funnel
7. Sky-space of Meditation funnel
8. Aquatic circulation
9. Steam space
10. Private access to changing rooms and Aquatics area
11. Private Roof Garden and sun space
12. Cold Baths
13. Hot Baths

10' 20' 40' 80'

plan 4 +35'

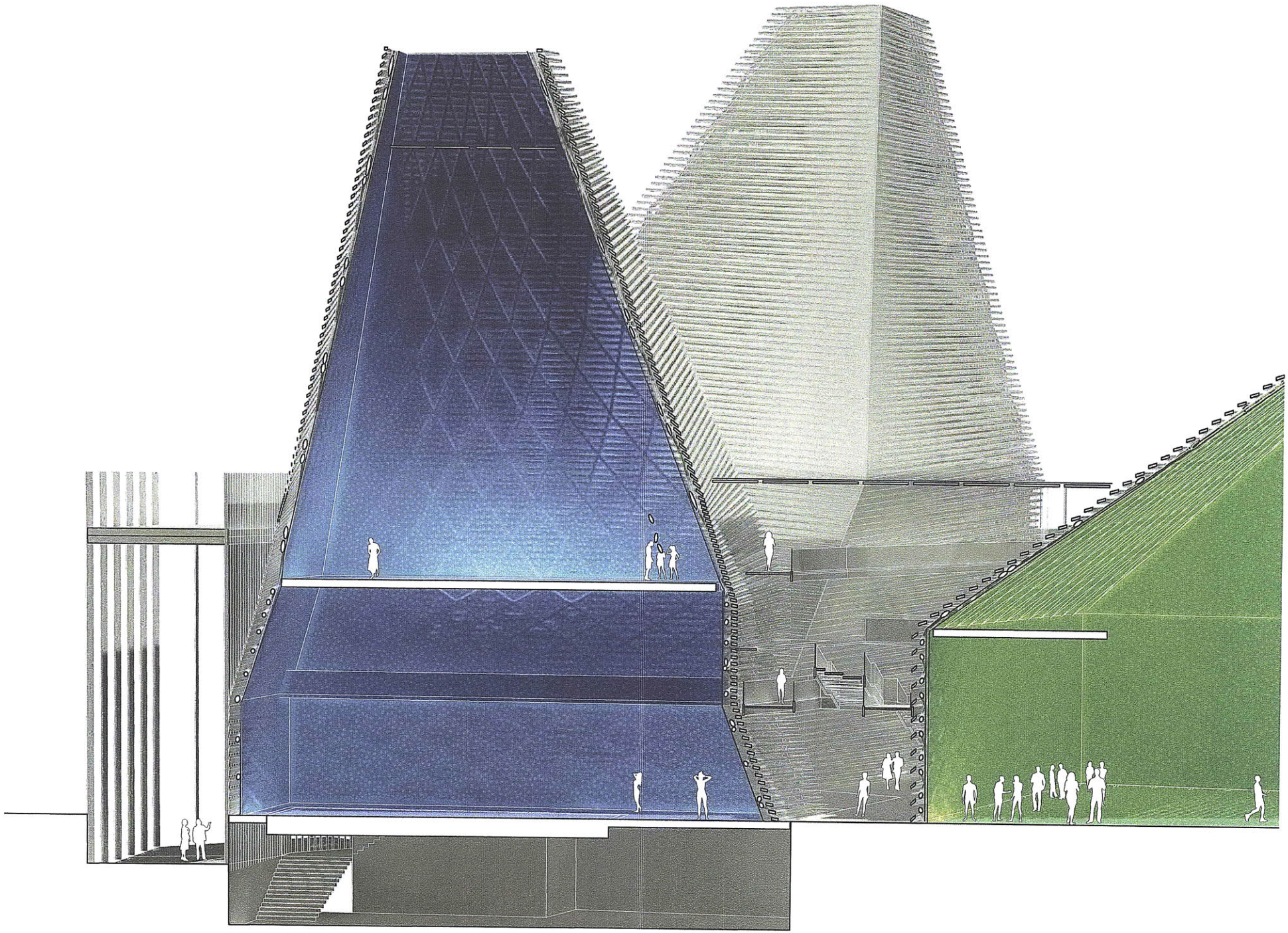


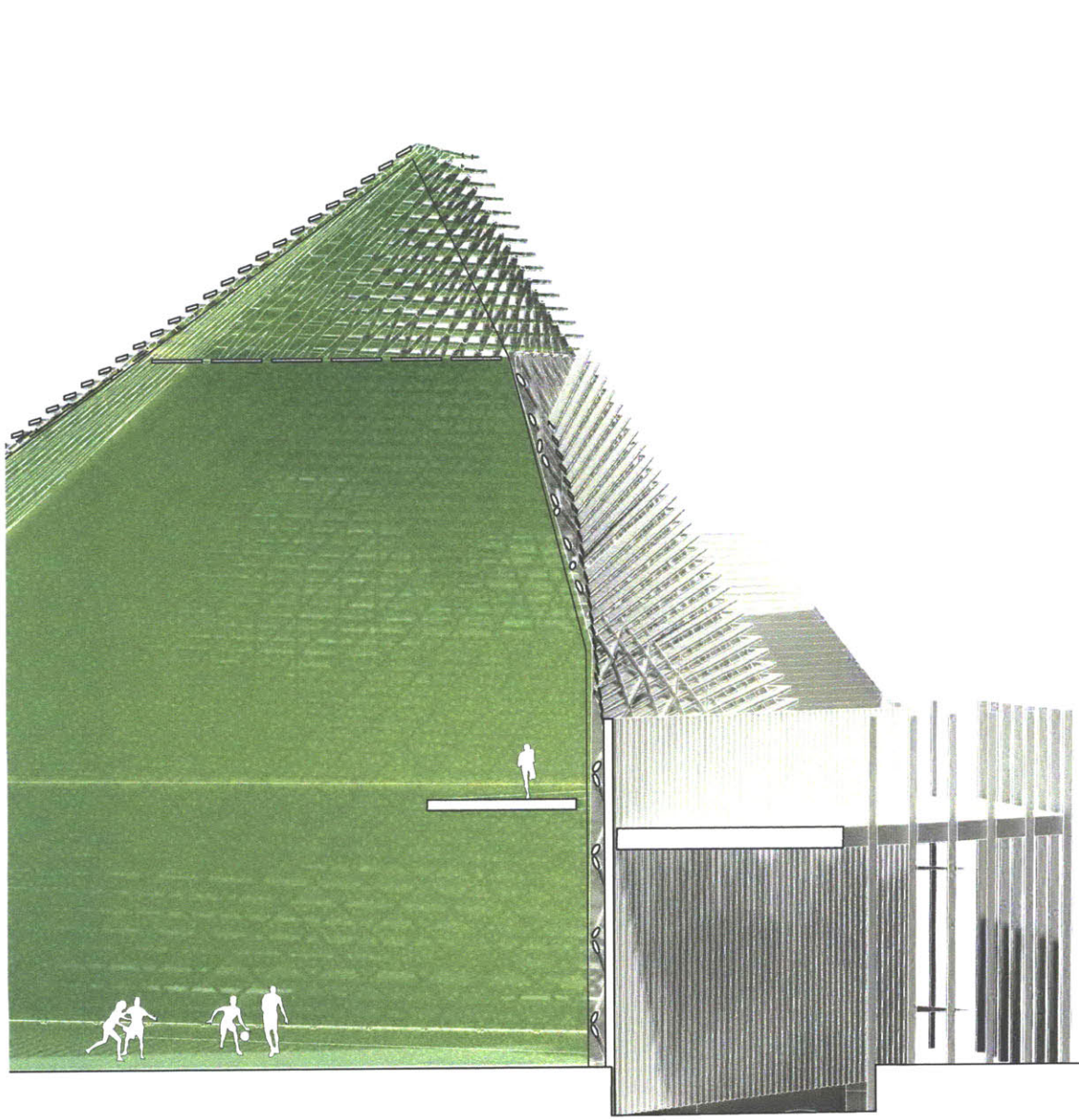


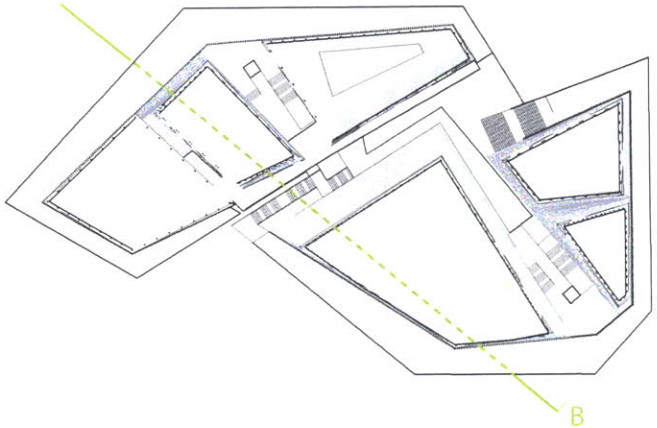


Section A

5′ 10′ 15′ 30′







Section B

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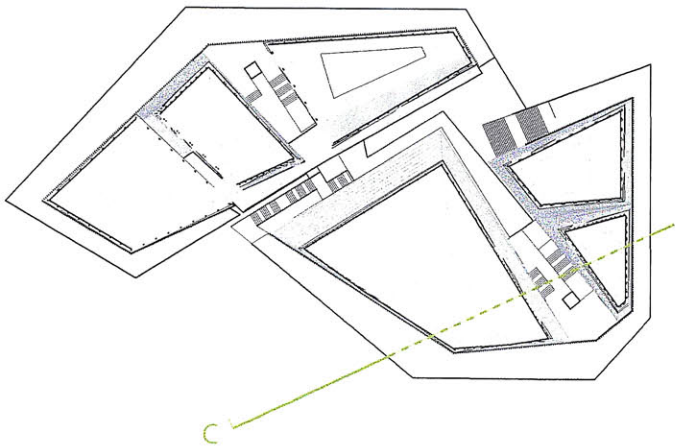

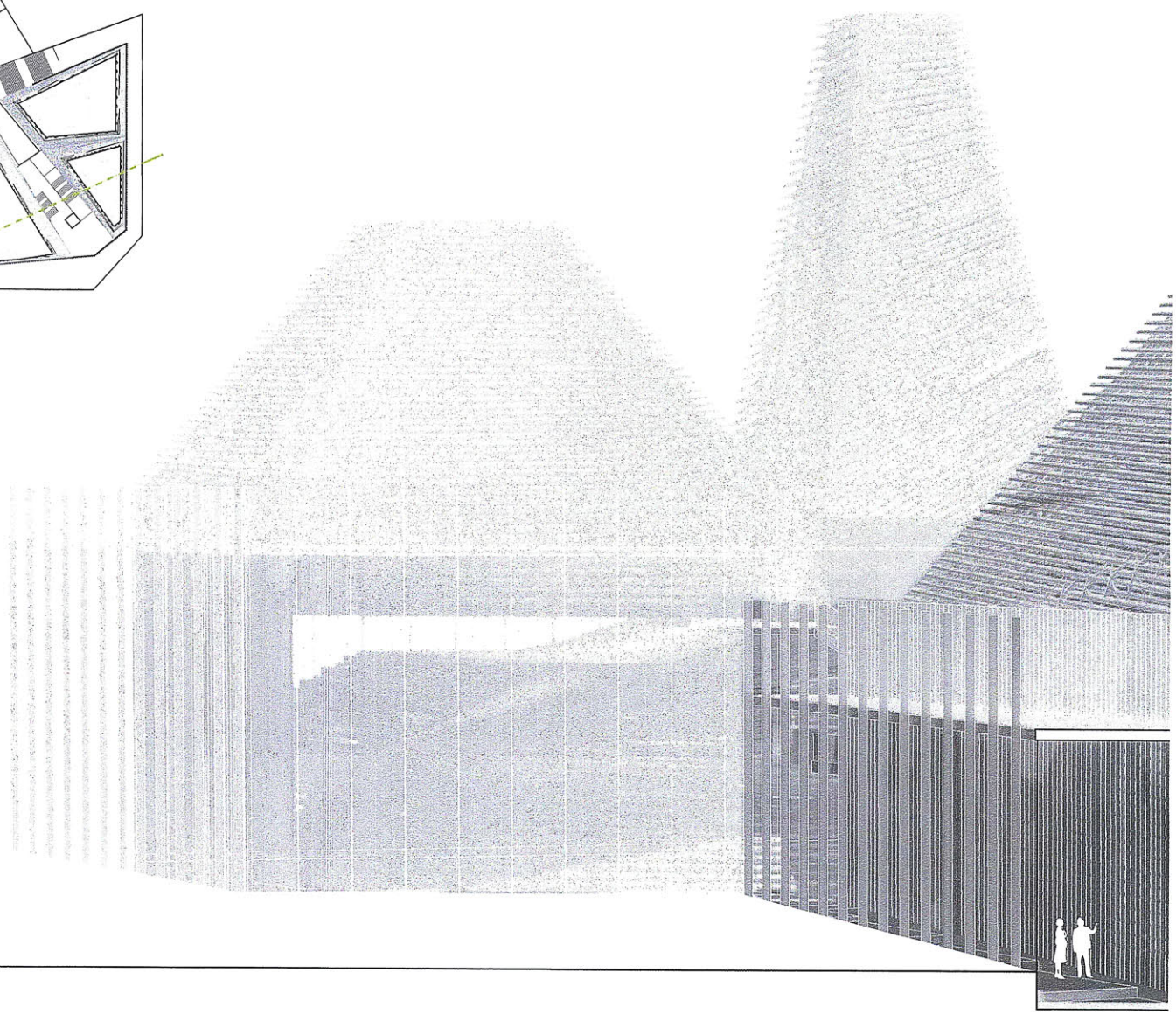

Section C

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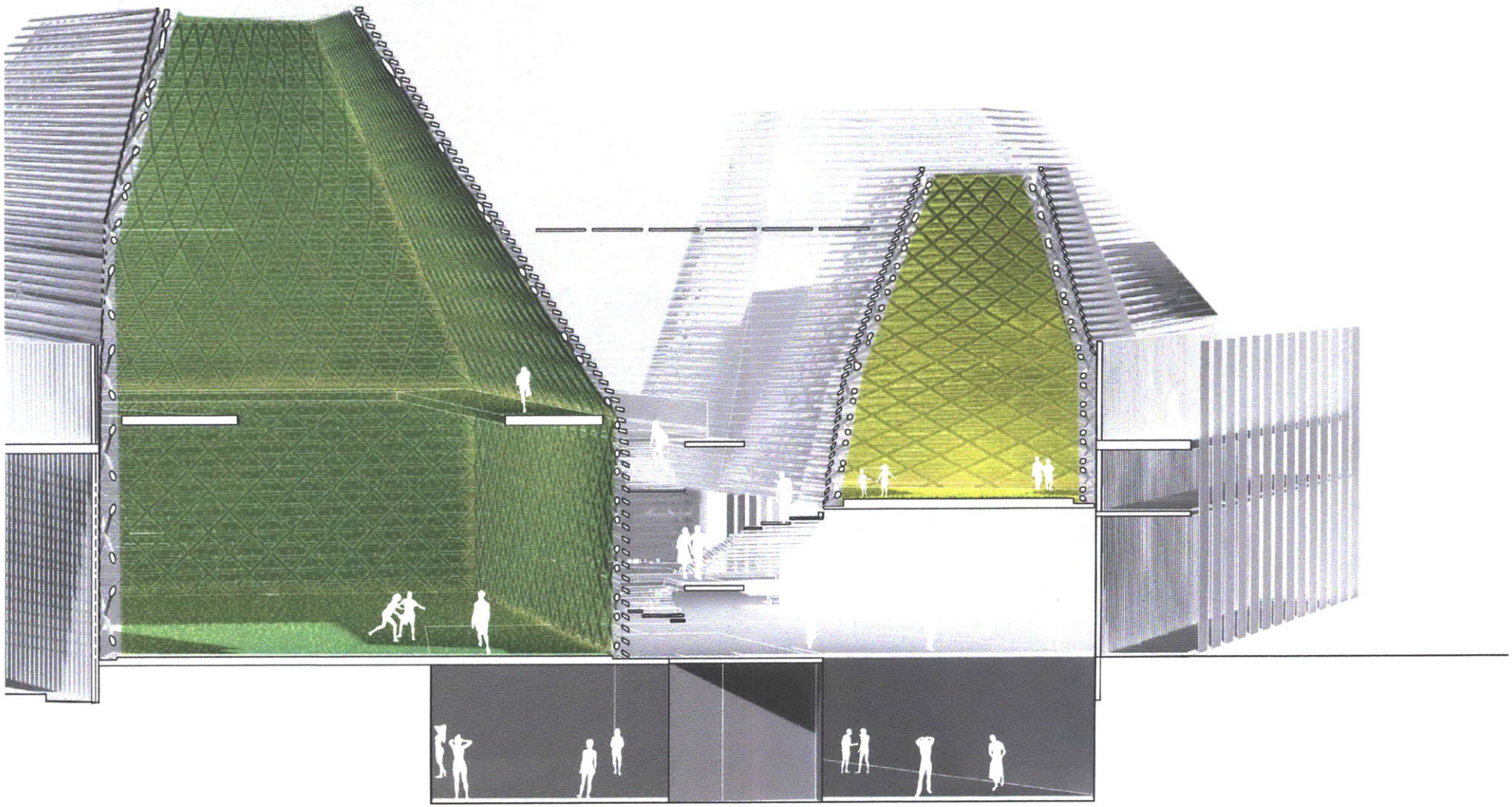
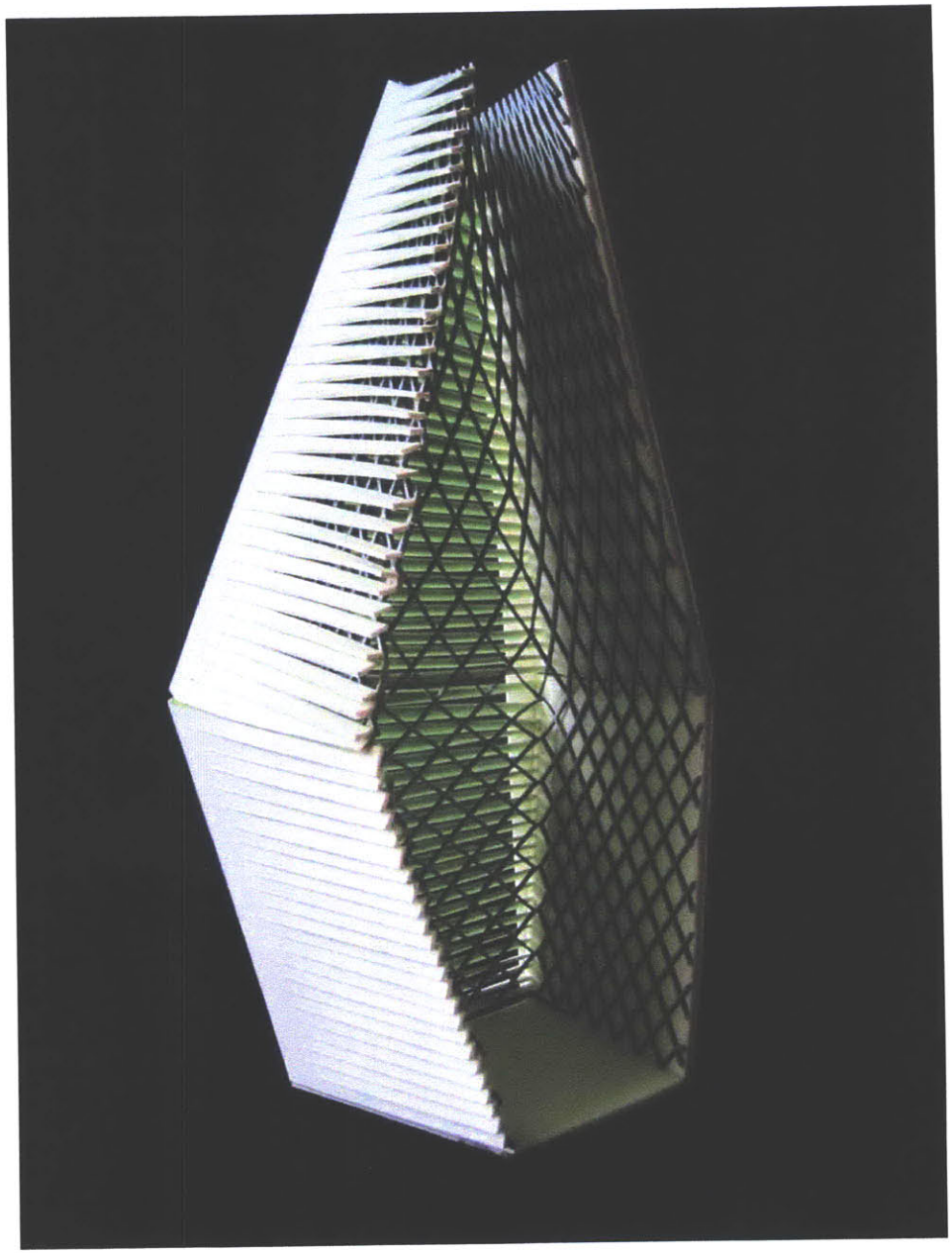
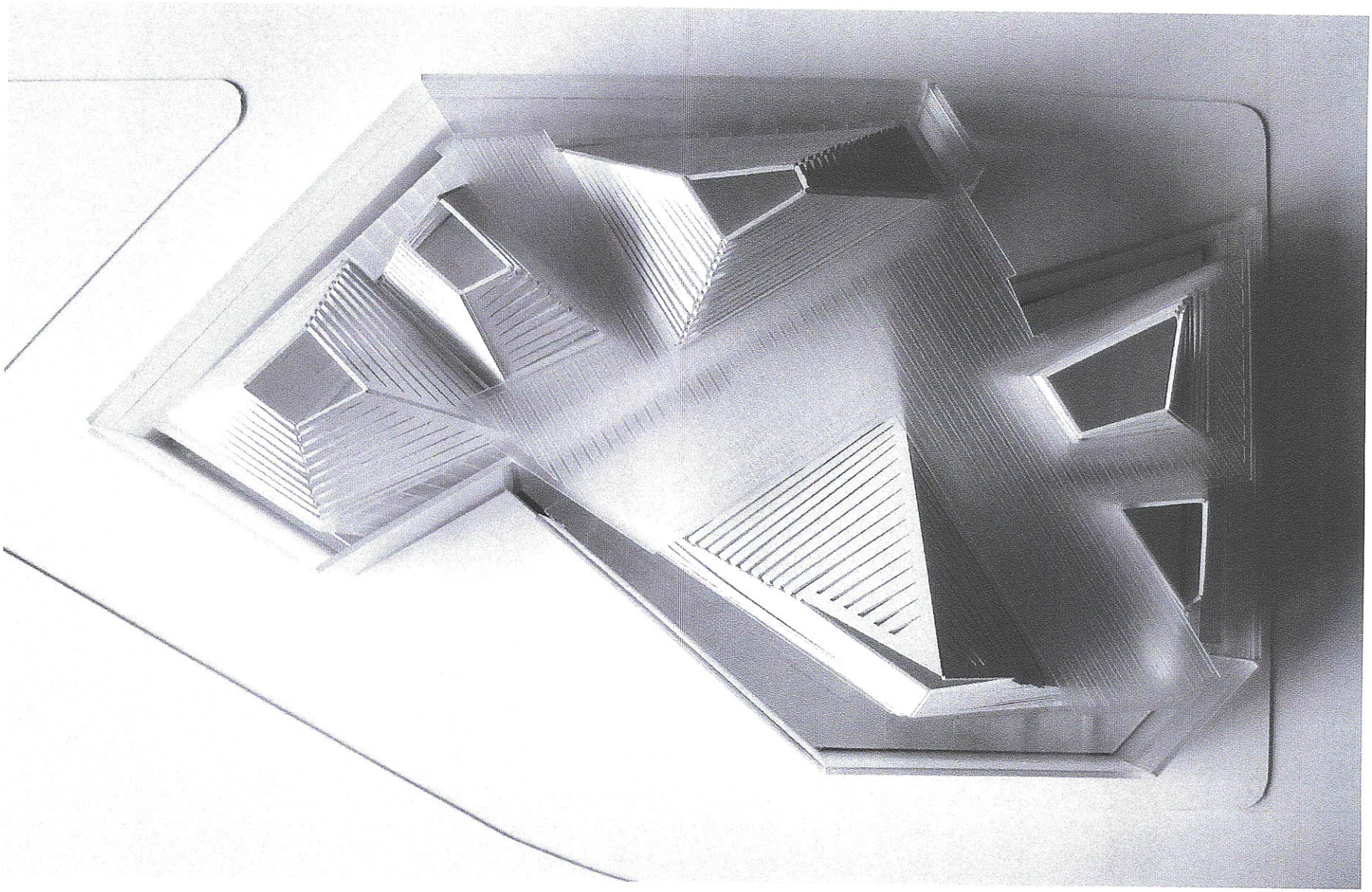
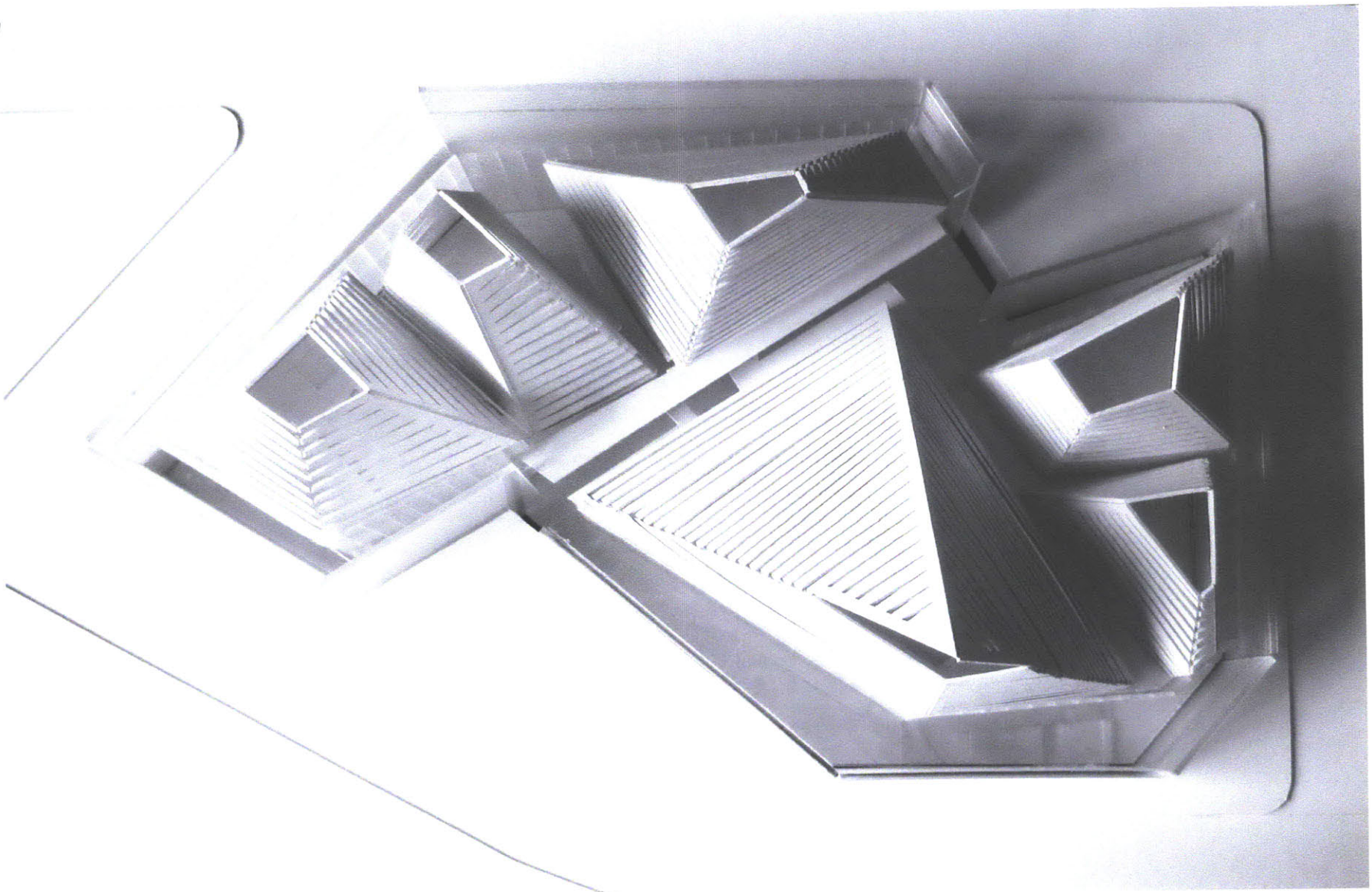
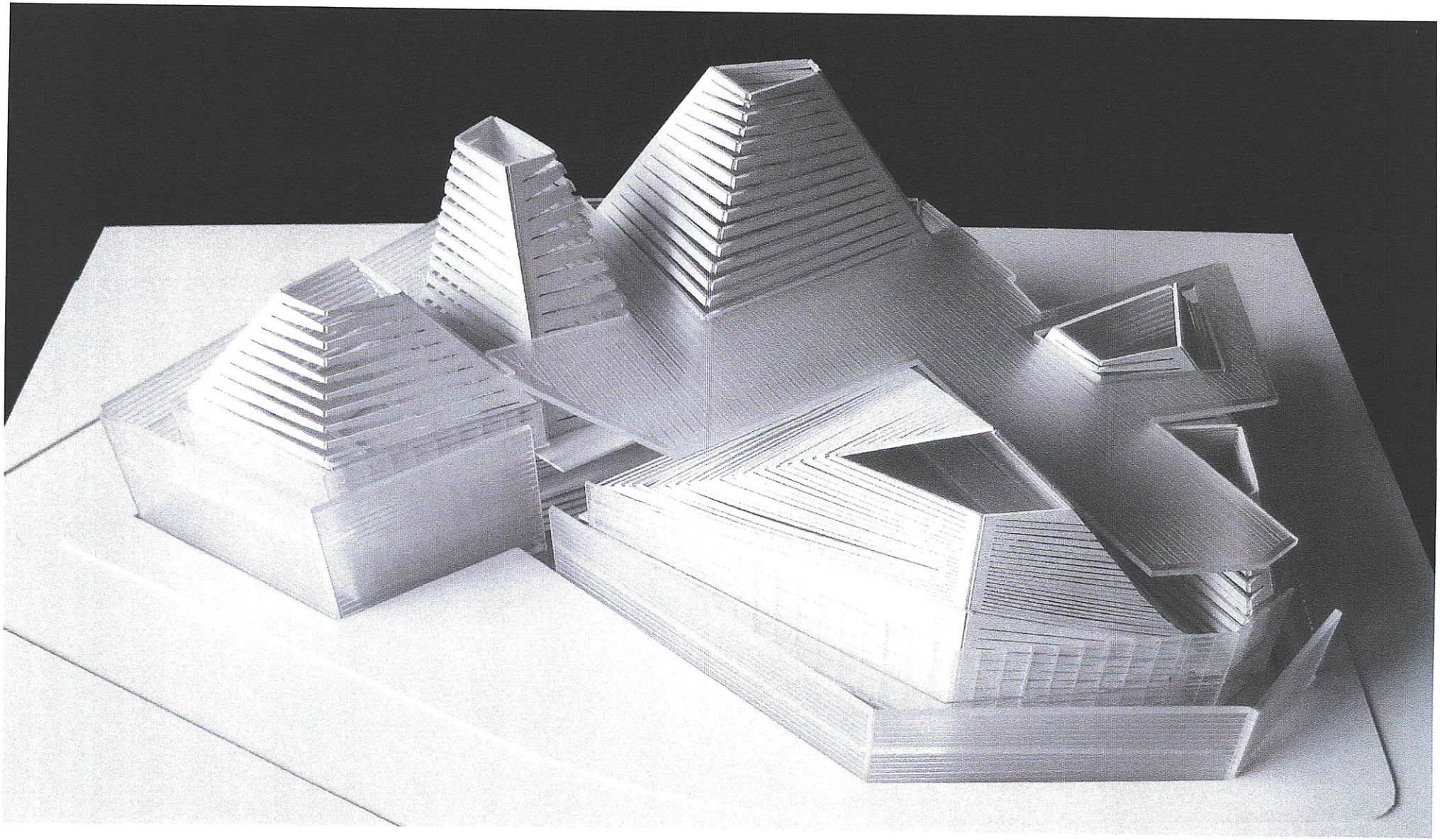


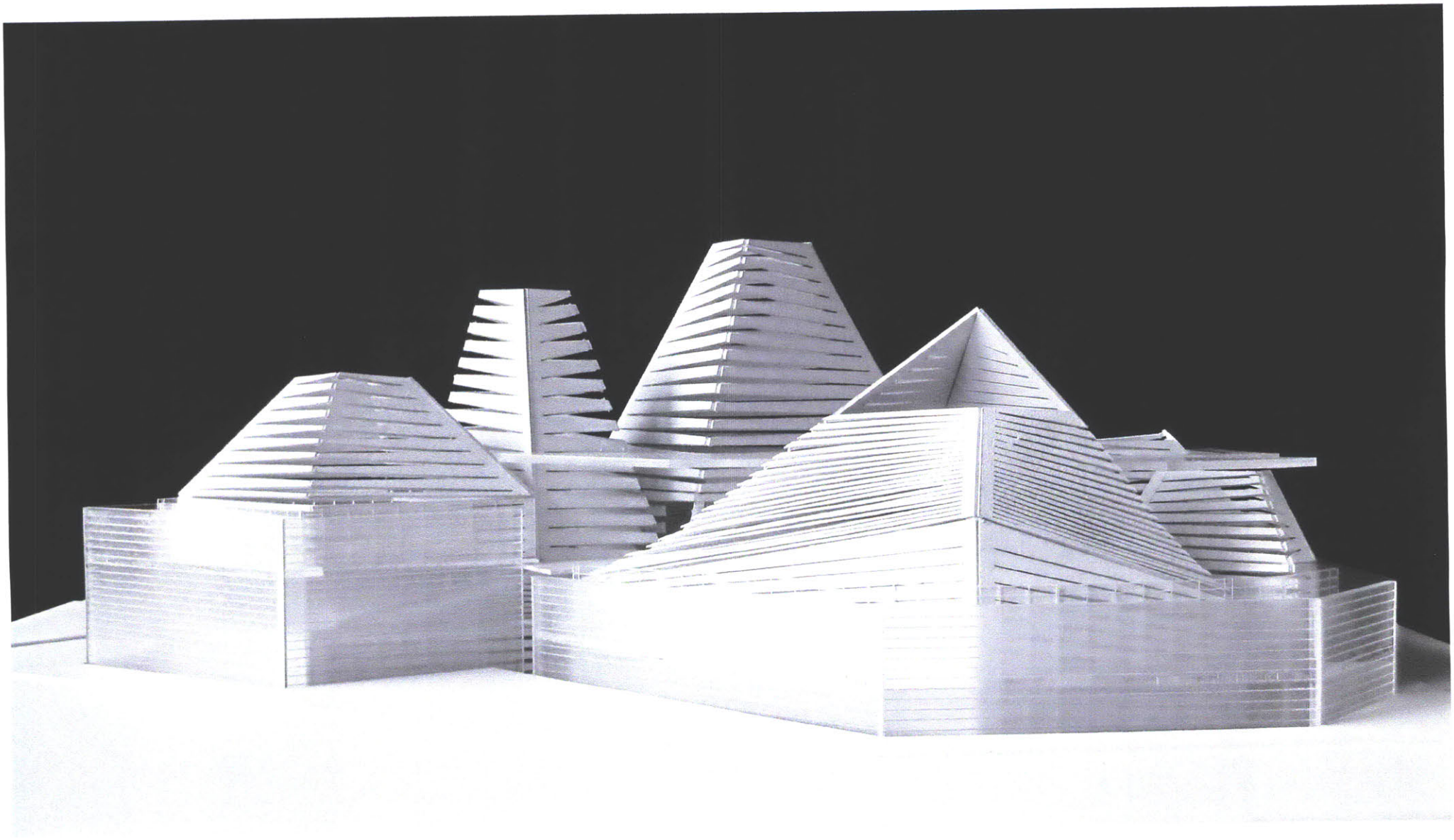
FINAL DESIGN
Final Models

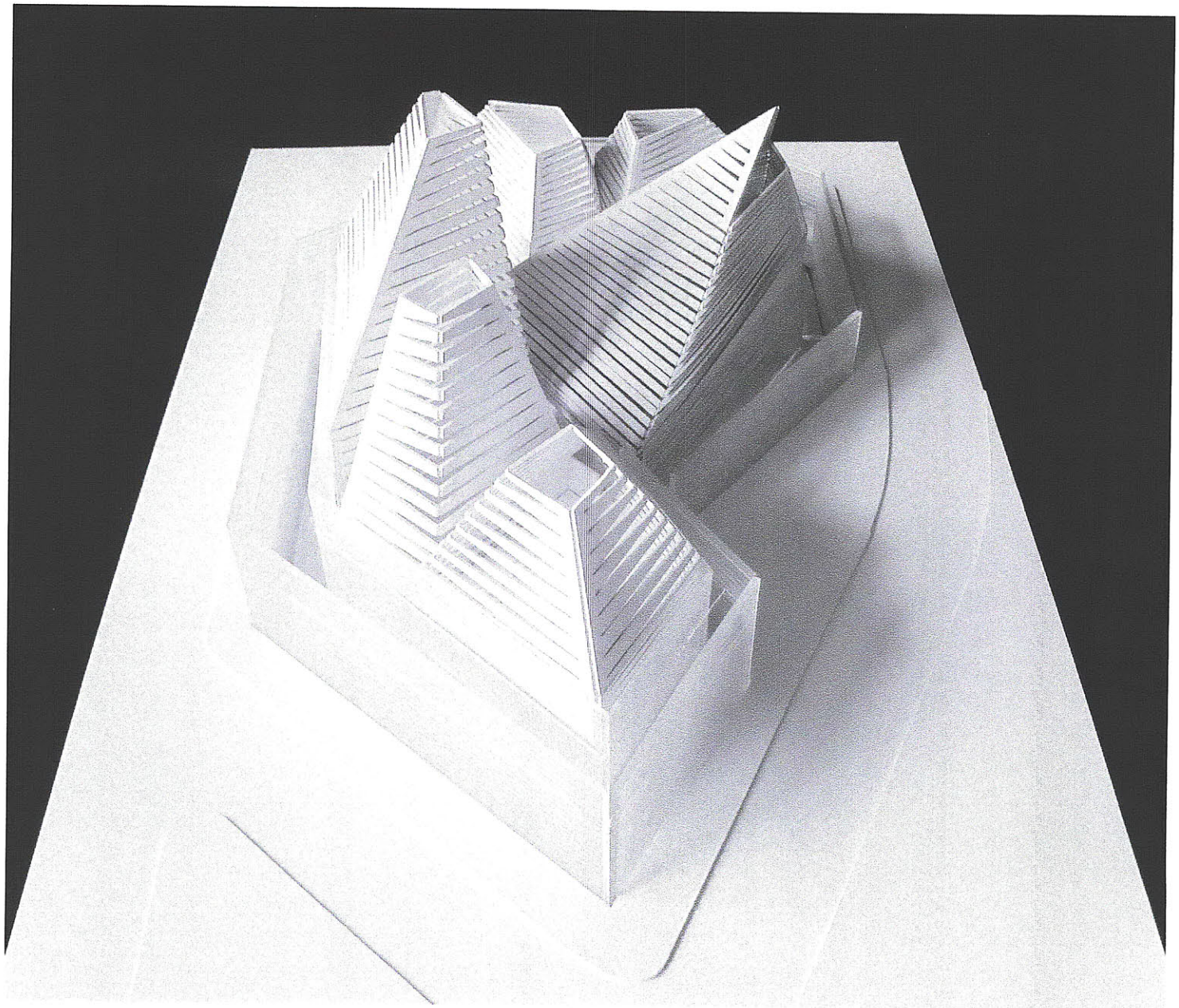




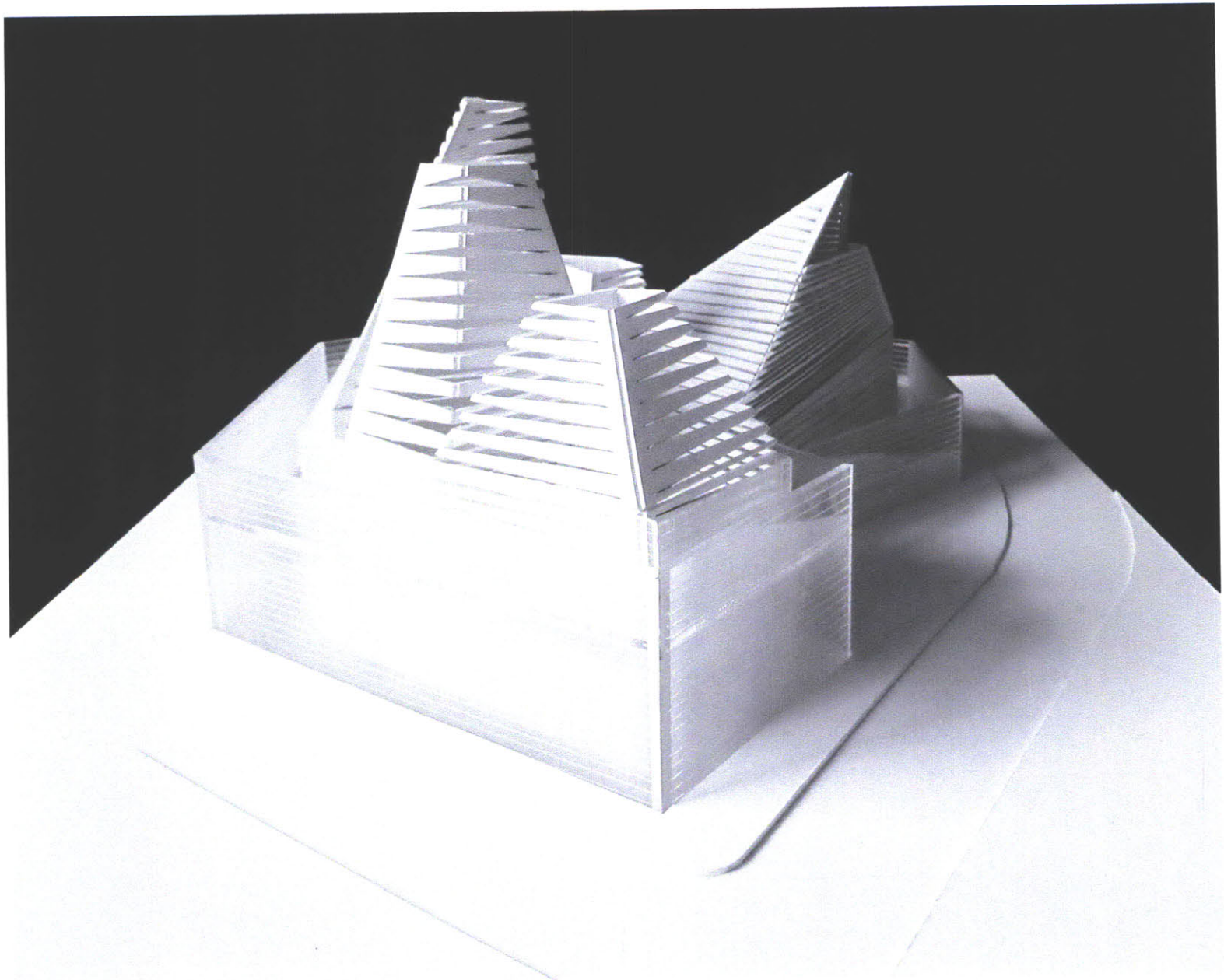


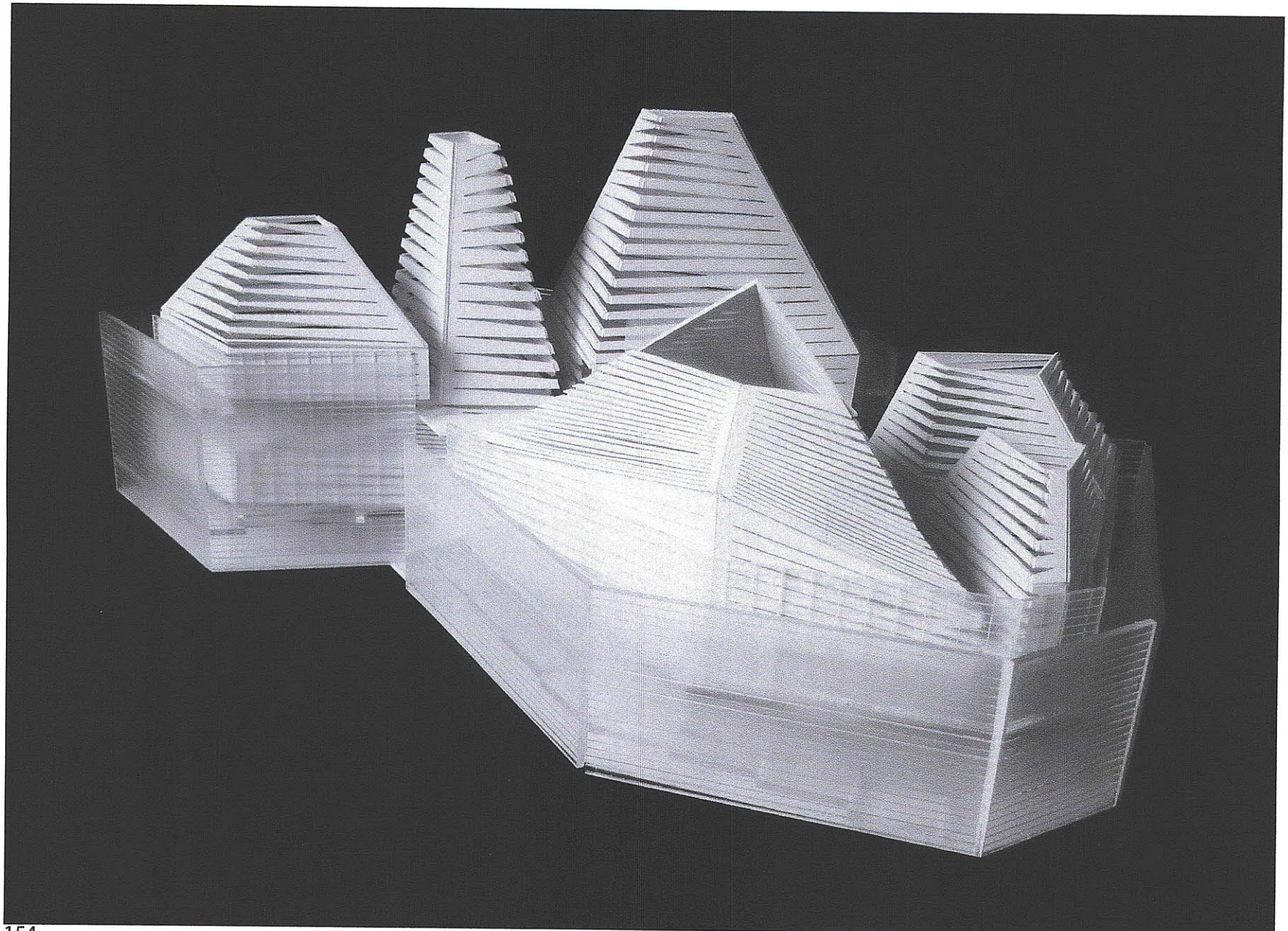




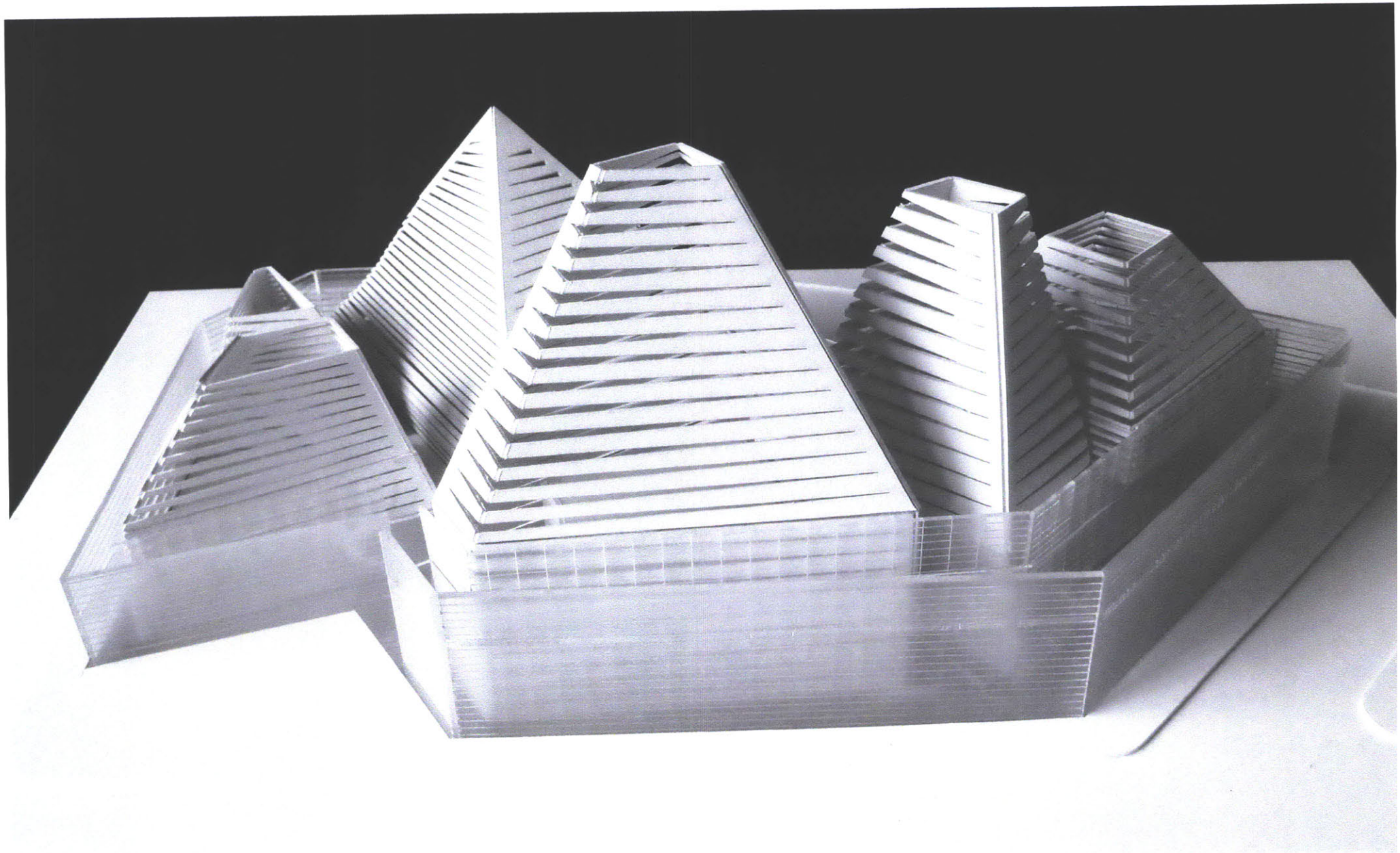


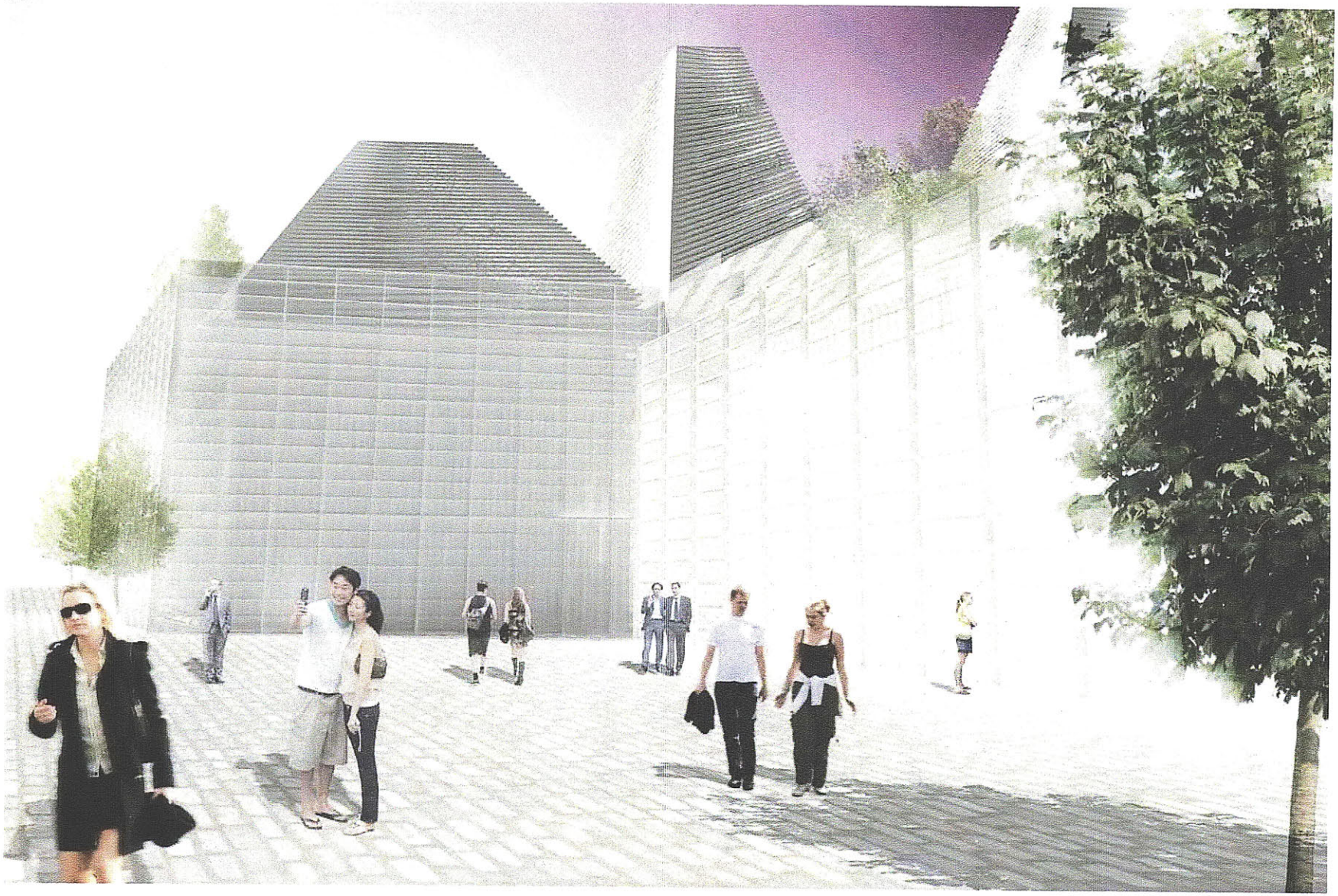
Final Models





Final Models





Exterior render of entry on residential edge

FINAL DESIGN
Criticism_ Thoughts & Musings

As usual, I wish there was more time. The criticism that was offered at the final review was extremely valid, thoughtful, useful and interesting. I only wish these conversations could have occurred a few weeks early. Of course, this isn't possible because the project has to be brought to a certain level of completion for these conversations to take place, which regretfully only occurs at the crunch at the very end of the semester. Three major criticisms caught my attention.

There was some skepticism about the division of different temperatures into completely different spaces (ie. the hot and cold funnels being separated). It was suggested that temperatures should be mixed, or at least connected, so that excess heat from one space can be used for another space, and likewise, excess or leftover cold extracted from one space can be pumped into another. In this way, a circular system would be introduced to create an urban ecology within the funnels, in that energy and leftover heat/cold could be used to temper other spaces. A greater range of solutions and temperatures could have been introduced. For example, using an icehouse, where snow was collected in the winter from plowing the roads, and was used through the summer to cool spaces. On the other end of the gradient, greenhouses could be introduced to heat. I think that connecting the funnels could be very useful, especially to re-using leftover heated or cooled air. It is important for me to point out that each funnel does in fact use a gradient of temperatures, which I don't think was understand fully in the final presentation. While one is called "cold" it is not one solid temperature, but there is a range in temperatures from ice cold to cool to tepid.

The critics agreed that the solutions were too generic. I completely agree with this, and struggled with the funnel forms throughout the design process. Perhaps if there were more goals layered within each funnel, with more specificity, it would make for richer solutions. Likewise, if a number of ways to achieve goals were layered into each form, it would make the solutions more believable, less homogeneous, and more informed.

Within the goals of the thesis was the exploration of organizing program based on thermal comfort within project. In the design process, programmatic organization became a bit stagnant. Thermal programming should be evolving so that program can move based on exterior weather. Then, the space becomes a museum of gradients, in which users move through the space based on individual comfort levels, which are different for everyone. Thermal programming would lend itself to spaces being used differently throughout the year, so that in the summer, spaces move down where the cooler air is, and in the winter, occupation is higher up within the funnels, where the hot air rises.

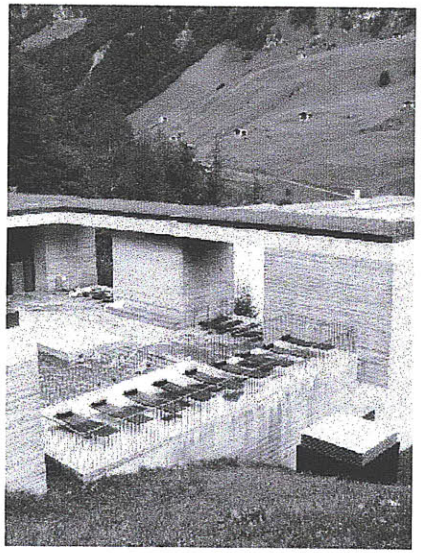
I would love to take all of these criticisms into account and take another design-go at this project, but time is up. I think that these ideas will stay with me, and inform future projects. This is the wonderful thing about design: ideas never die. I believe these issues will continue to reappear in different, more informed ways throughout my career. So, until then, adieu.

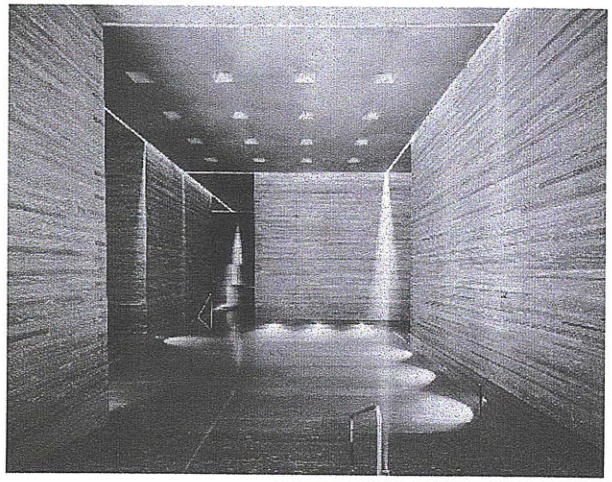
Hygeia* weatherized

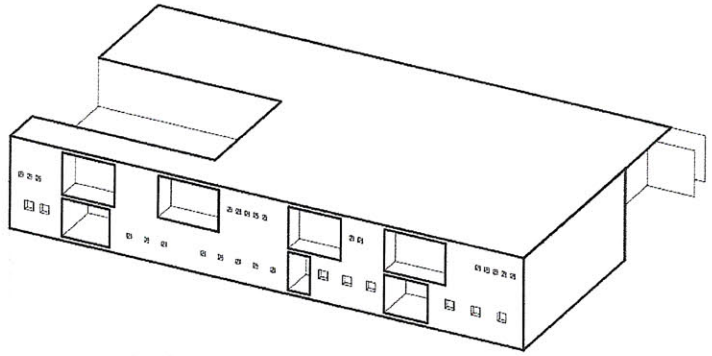
Research Appendix

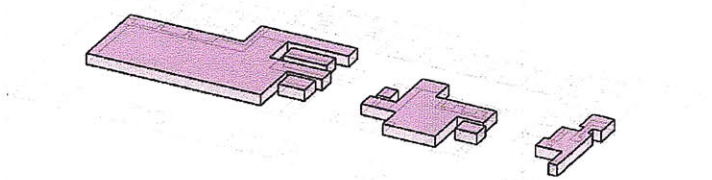
Thermal Baths

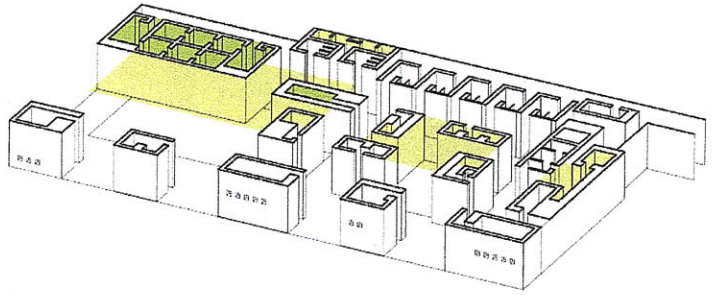
architect: Peter Zumthor
location: Vals, Switzerland
type: thermal bath
size:

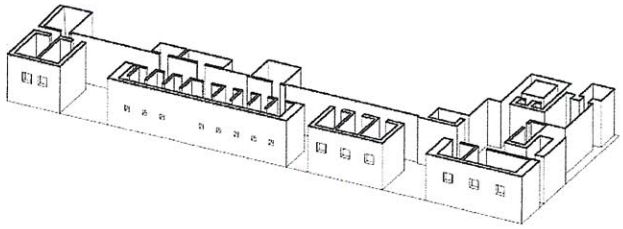








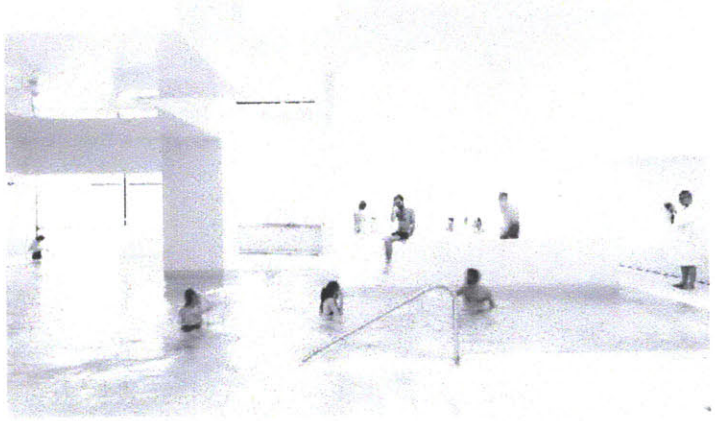


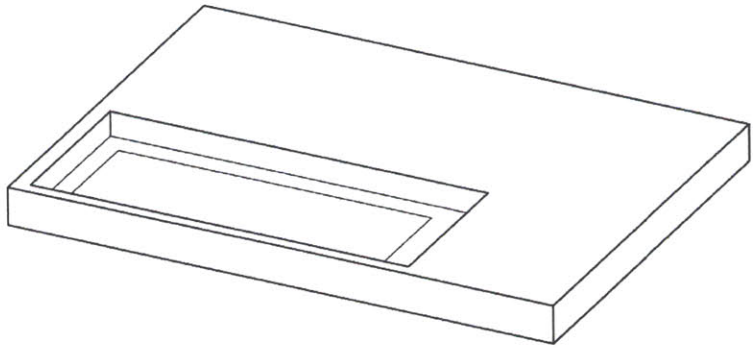


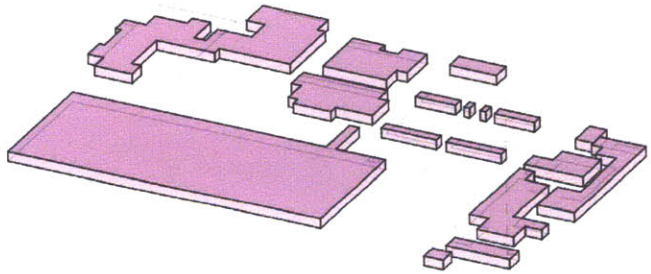
Program

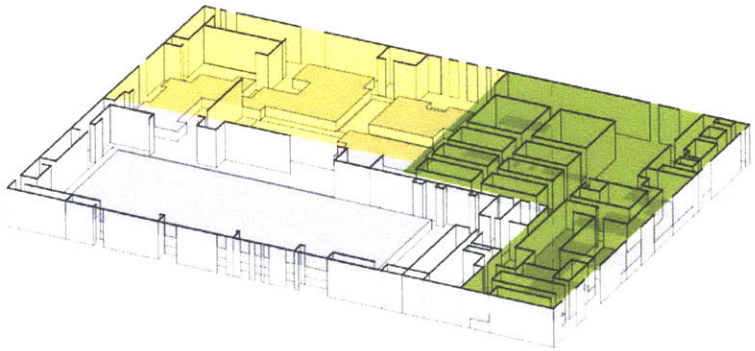
Les Bains des Docks

architect:	Jean Nouvel
location:	Le Havre, France
type:	aquatic center (pool, spa)
size:	5,000 sq-meter





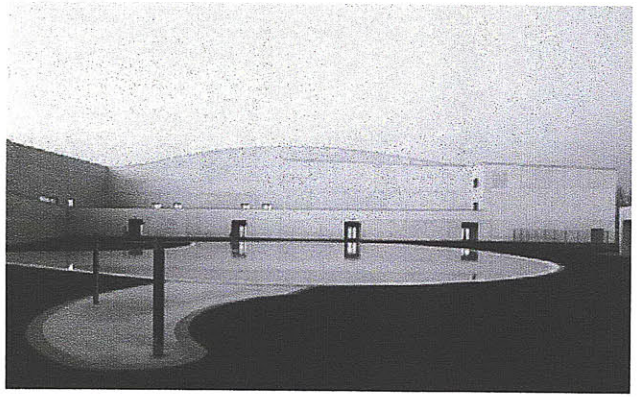


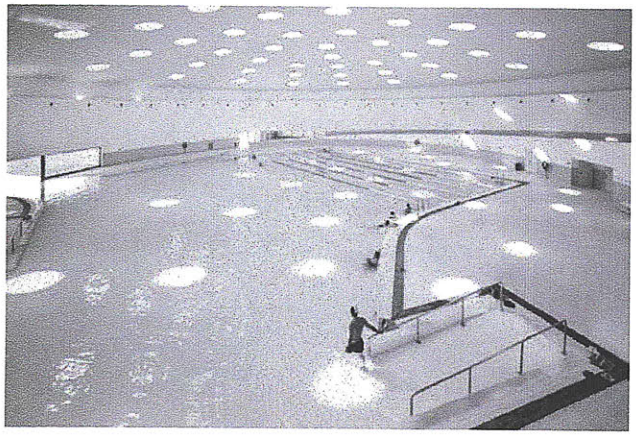


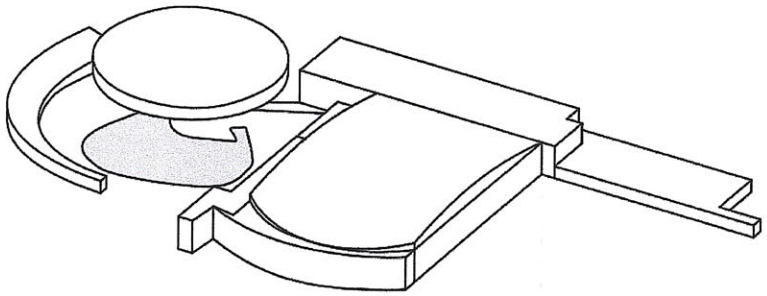
Program

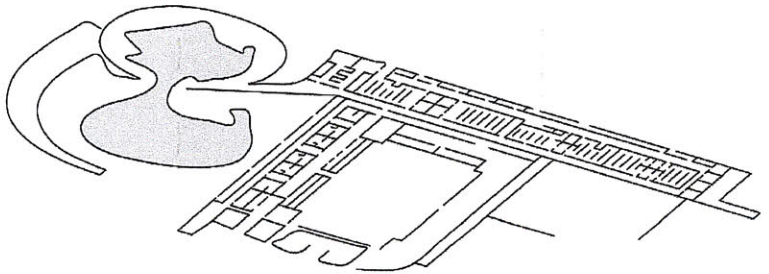
Sports Complex

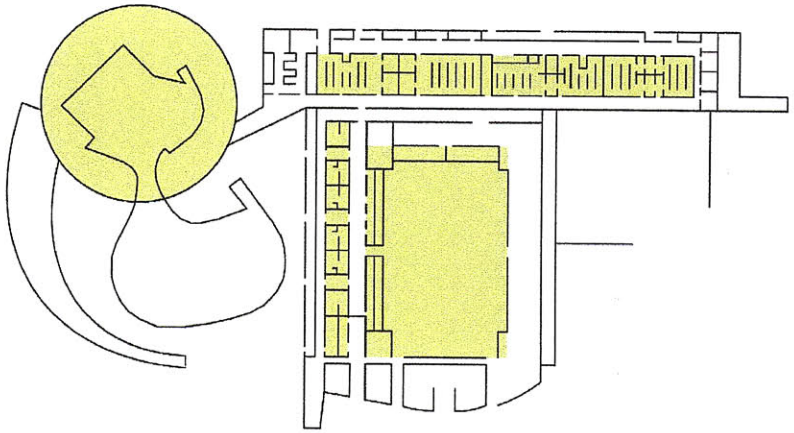
architect:	Alvaro Siza
location:	Barcelona, Spain
type:	sports (basketball, pool, etc)
size:	40,000 sq-ft







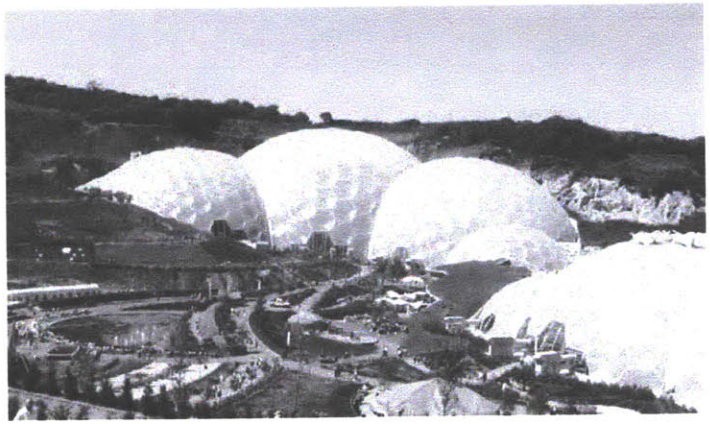


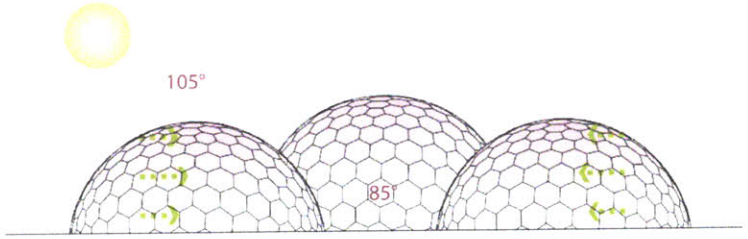


Eden Project

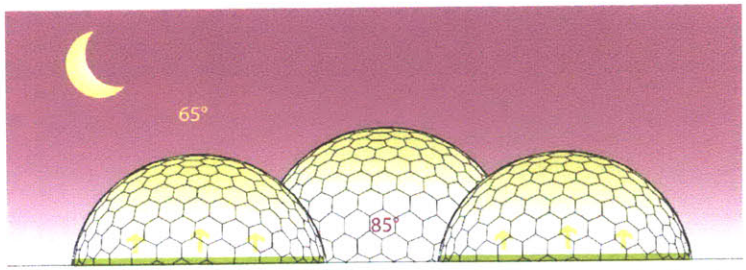
architect:	Nicholas Grimshaw
location:	Cornwall, UK
type:	artificial biomes
size:	Tropical Biome:
	(3.9 acres: 328' x 656')
	Meditteranean Biome:
	(1.6 acres: 213' x 443')

environmental





cools by ventilation + evaporation

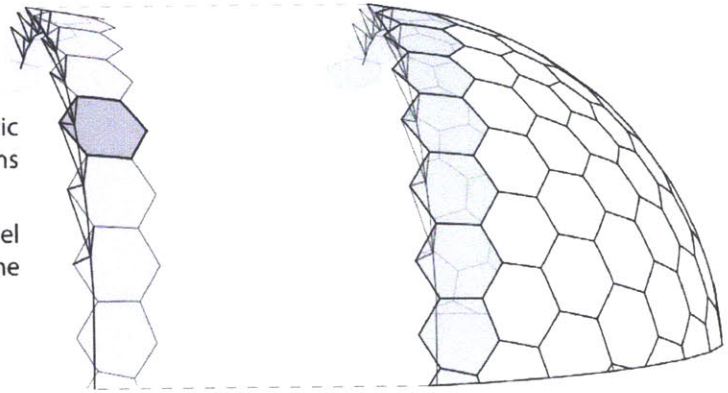


warms by steam or hydronics

Roof (closed)

thermoplastic ETFE cushions

tubular steel space frame



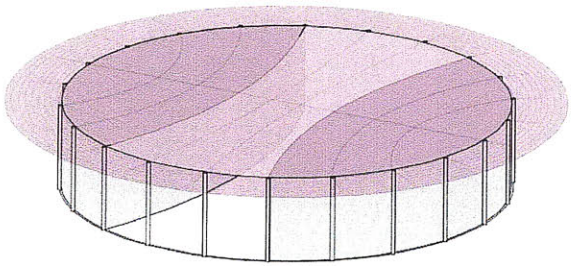
Petronas University of Technology

environmental

public space

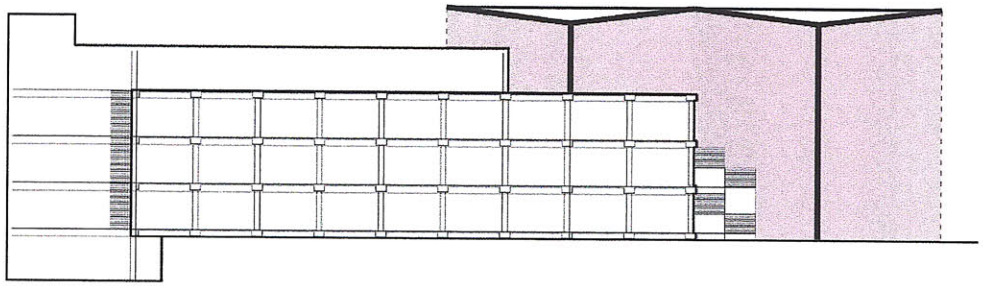
Roof (open)

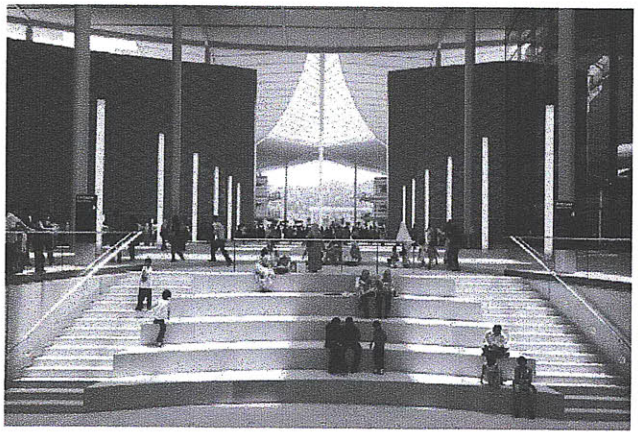
architect:	Foster + Partners
location:	Seri Iskandar, Malaysia
type:	university
size:	450-hectacre site

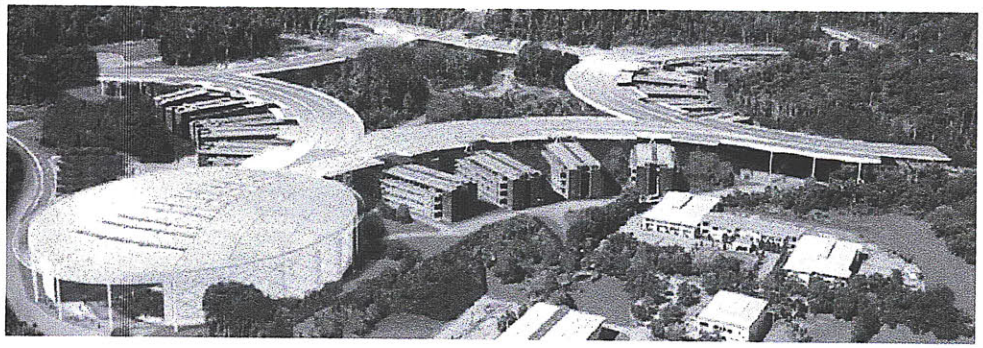


Roof Canopies
designed to:

1. maximize air flow + ventilation
2. provide protection from solar radiation
3. provide protection from heavy downpours during monsoon season







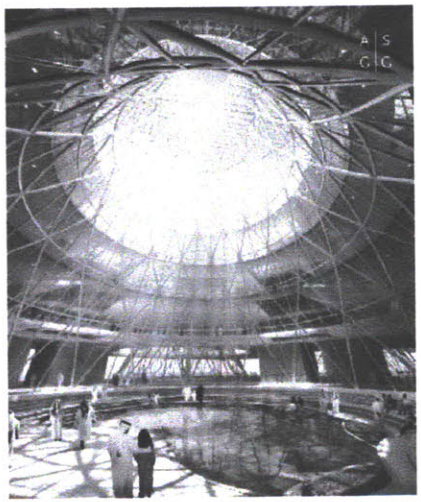
Masdar Headquarters

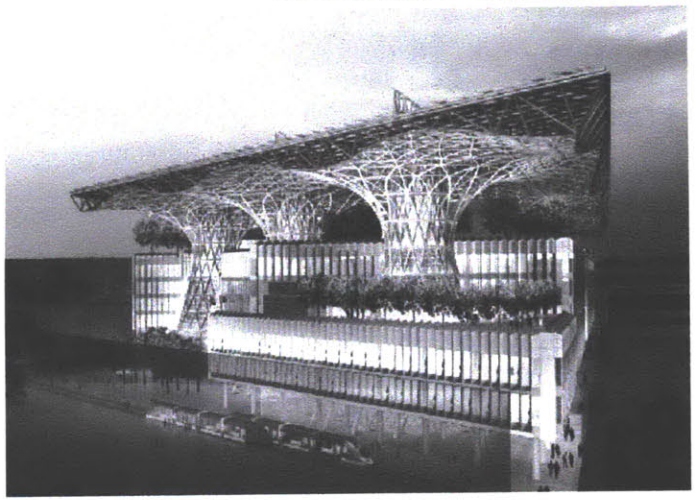
environmental

public hybrid

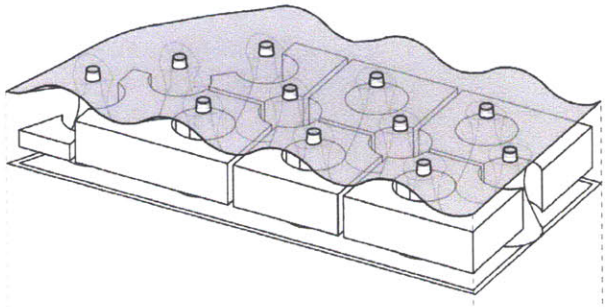
Roof (open)

architect: Adrian Smith + Gordon Gill
location: Masdar City, UAE
type: mixed-use
(commercial, retail and cultural uses)
size: 1,500,000 square feet

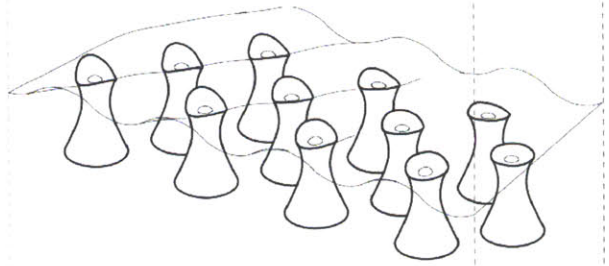




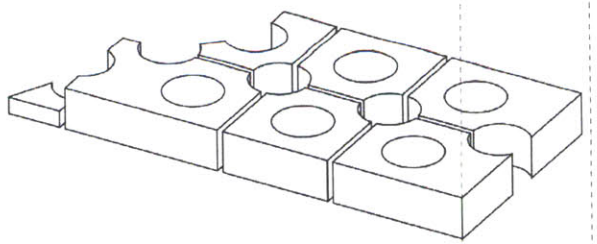
roof canopy: provides natural shading, photovoltaic and solar-panel arrays



eleven wind cones: provide natural ventilation and cooling, form "oasis" courtyards, provide soft daylighting



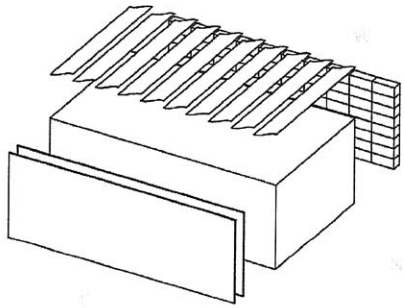
7 stories high-thermal-mass exterior glass cladding provides solar heat blocking

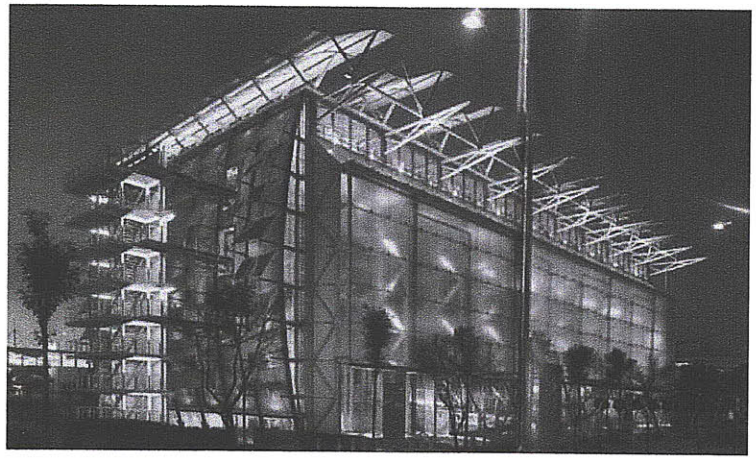


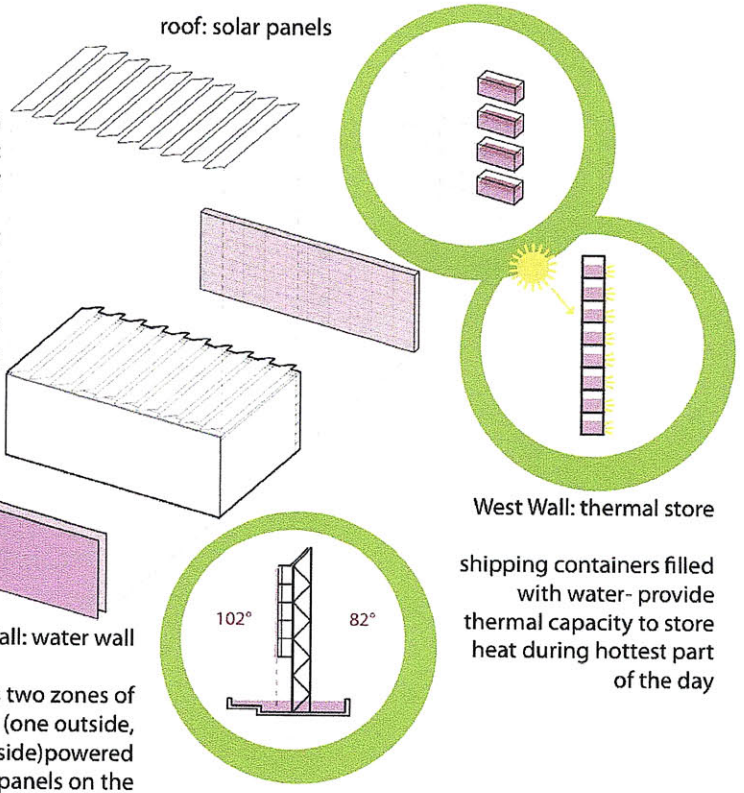
plan: each courtyard is programmed differently, providing amenities + pubic space

British Pavilion, Expo '92

architect:	Nicholas Grimshaw
location:	Seville, Spain
type:	temporary pavilion
size:	24,000 square feet (120' x 200')



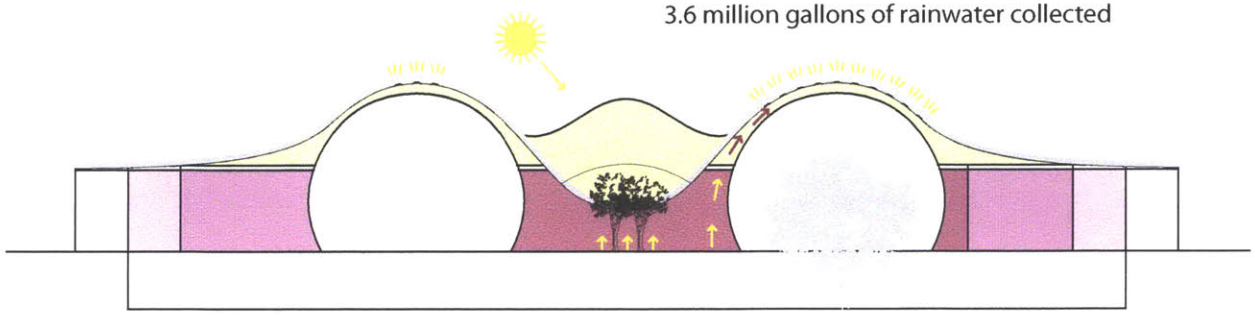




California Academy of Sciences

architect:	Renzo Piano
location:	San Francisco, CA
type:	museum
size:	197,000 square feet of roof

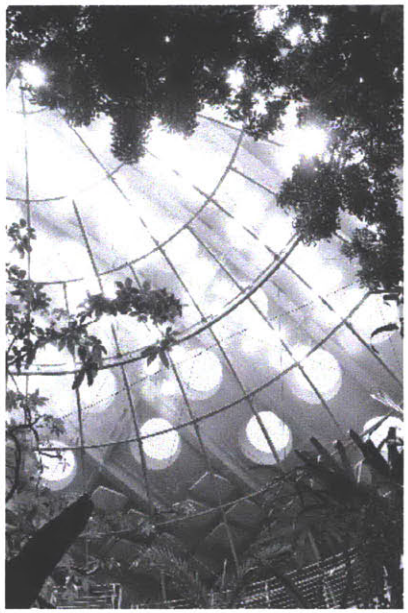
197,000 square feet of roof!
6" soil
3.6 million gallons of rainwater collected



roof's role in passive design:
1- green roof will keep building's interior 10° cooler (counteracting 'urban heat island' effect)
2- exchanges carbon dioxide to oxygen via photosynthesis
3- captures rainwater
4- reduces energy needs for heating and cooling

environmental

Roof (closed)



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